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ABSTRACT

This unit is intended to give students an understanding of the influence that various sources of energy have had on culture and on understanding of the effects of energy change. Physical properties of wood, coal, and oil are examined, and the ability of these substances to give heat is considered. Students practice the mathematics necessary to understand energy conversion. (Author/RE)

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Interdisciplinary Student/Teacher Materials in Energy, the Environment, and the Economy

Energy Transitions in U.S. History

Grades 8-9

June 1979

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June 1979
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Energy Transitions in U.S. History

Introduction

Today, as in the past, the United States depends on several primary sources of energy to satisfy its large demand. The historical part of the energy story covers two almost complete transformations of the nation's energy base. The first occurred around 1850 when the nation changed from wood to coal. The second cocurred around 1920 when the nation moved into the Petroleum Age. Since this time the U.S. has lived mainly in an oil based culture. There is much evidence that this will change.

Each of the earlier energy eras, the age of wood and the age of coal, affected the culture of the period. Each transition from one primary energy source to another was brought about by the interaction of changes in technology, increases in population, and the availability of resources. Each transformation brough both benefits and harm to the society.

This is essentially a history unit. It is aimed at giving students an understanding of the influence that each source of energy has on the culture and of the impact of energy change. The physical properties of wood, coal and oil, are studied. Specifically the ability of these substances to give heat is explored. The students have practice with the mathematics necessary to understand energy conversion. It is hoped that the cultural and historical perspective represented, along with the mathematical and scientific knowledge, will help students understand the necessity to reexamine and perhaps alter our present energy patterns.

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T - Teacher Manual

Teacher Manual

To the Teacher

The purpose of the Teacher Manual is to help you use Energy Transitions in United States History to best advantage when infusing energy-related topics into your Social Studies, Science or Math course. The Teacher Manual consists of two parts: (1) an introduction (see table of contents on the previous page), and (2) the main ideas, strategies, materials, and attainable goals for each classroom lesson.

You will find the students' material printed on white stock behind this Teacher Manual. These exercises and activities can be easily duplicated into classroom sets. Complete student material for each lesson has been provided (see table of contents).

America's Wooden Age
(1650-1820)

1. The Colonial Period

Overview

The period from the founding of the country to the three-quarter mark of the 19th century can be understood partly in light of the primary energy sources available to the people. These were renewable resources of the sun, wind, water and wood, as well as animal and muscle power. The interaction of human needs and wants with the resources of energy helped to shape the culture of the developing nation. As new technologies developed, as population grew, and as desires increased, new sources of energy were needed.

Objectives

Students should be able to:

1. State reasons for the reliance on wood and animal power.
2. Make inferences from a variety of data.
3. Identify attitudes about energy use from selected primary source material.

Target Audience

Social Studies.

Time Allotment

Two-three class periods.

Materials

Class sets of:

Student Handout 1, "The Death of Trees," p 63, and Questions to Accompany Student Handout 1, pp 64-65

Student Handout 2, "The Indian View of the Pilgrim Landing" and "William Penn," p 66, and Questions to Accompany Student Handout 2, p 67

Student Handout 3, "Domestic Energy Use," p 68, and Questions to Accompany Student Handout 3, p 69

Student Handout 4, "Diary of a Colonial Farmer," pp 70-71

Student Handout 5, "Energy and Cultural Patterns: The Colonial Farm," p 72

Teaching Strategies

Begin the lesson by asking the students to visualize themselves in a forest wilderness with a few simple tools such as a saw, ax, pick, and hand plow. They wish to farm the land. What tasks must be done? Who will do them? How? Would you like to do this kind of work? Why?

To help the students realize the enormous effort that goes into clearing land you could have them describe experiences of chopping wood or carrying wood for their fireplaces. Perhaps if there are wooden desks in the room, the students could carry the desks to see how heavy wood can be.

Student Handout 1

Pass out class sets of Handout 1, "The Death of Trees." Have students read the selection and then answer the questions.

<u>NOTE</u>: Be careful not to give the impression that the U.S. transition from wood to coal took place because we "ran out" of wood. Wood became a less popular form of energy as fossil f[illegible] technology advanced.

<u>Student Handout 1</u>
<u>Questions and Answers</u>

1. Of what place and what time does this account tell?
   (British Isles, 16th century.)

2. What was the most widely used fuel at this time? Why was it such a good source?
   (Wood; it was available in great quantities. It needed no processing.)

3. What were some of the uses of wood during this time?
   (Heating homes, cooking food, some new industries.)

4. According to the reading, what did the people do when the local supply of wood ran out?
   (Moved to new areas.)

5. Why was there no attempt to conserve (save) forests at this time?
   (It didn't occur to people that they might run out of wood.)

Thinking It Over

6. Although some people suffered when industry used forests, some people benefited. Compare the drawbacks and the benefits of sharing the primary source of energy with the new industries. *(There was plenty of fuel to run the new industries so they continued to grow. However, the benefits of this growth were available only to the people who were involved in the industry. Unfortunately, the rest of the population did not benefit from the presence of the industries. They just ran out of wood faster.)*

7. How is the energy situation today similar to England's in the past? *(Students can discuss the present oil situation.)*

Student Handout 2

This activity asks the students to consider the attitudes of two groups of people toward the same resource -- land. They are asked to see how these attitudes reflect the lifestyle of the two groups.

Have students read Handout 2, "The Indian View of the Pilgrim Landing" and "William Penn." Then answer the questions.

<u>Student Handout 2</u>
<u>Questions and Answers</u>

1. The chief spoke of a huge canoe with white blankets. What did he mean?
   (A sailing ship.)

2. Why was the chief sad?
   (The Indians and the settlers could not seem to share the land. The Indians signed a peace treaty and taught the settlers how to plant corn, but they got nothing in return.)

3. What uses did the Indians have for the forests?
   (Students' answers will vary. Accept all reasonable responses.)

4. Why was William Penn so happy with the land in the New World?
   (The land was very rich and could produce; crops grew much better than in England.)

5. Why do you think the settlers cut down the trees?
   (Students' answers will vary. Accept all reasonable responses. Emphasize that the settlers wanted to clear the land for farming.)

6. Compare the attitudes of the Indian Chief with William Penn about the use of land and trees.
   (The Indians lived within the forests, using only what they needed. The settlers didn't know how to live in the forests, so they cut down the forests to make farmland to produce food.)

Student Handout 3

This activity asks the students to gather and interpret materials from a picture. Have students look carefully at the picture and then answer the following questions.

Student Handout 3
Questions and Answers

1. What are the uses of wood in the picture?
(Students' answers will vary, but should include specifics under these headings: housing, energy, tools, furniture, etc.)

2. What are examples of energy being used in the picture?
(Boy carrying wood, man chopping wood, wood used for heating and cooking inside and outside, and woman churning butter.)

3. What objects show that human muscle power was used to produce the necessities of life?
(Butter churn, handmade furniture, spinning wheel.)

4. Why were wood and human energy used more in the colonial period than today?
(These were the only resources available; machines and tools were simple and did not need other forms of energy.)

The next two activities help the students to compare the types and use of energy in two different cultures: the colonial farm family and the family of today.

Student Handout 4

Student Handout 5

Distribute the "Diary of a Colonial Farmer." Have students read the selection and answer the questions on Handout 5, "Energy and Cultural Patterns: The Colonial Farm," where they examine relationships between energy use and cultural patterns. You can then have students complete a similar worksheet for their families.

Discuss with the class the differences in types and uses of energy in the two time periods. How do family roles and patterns differ? What makes a family wealthy today?

Note: This might be a good time to encourage your math teaching colleague in the unit. The math portion of this unit is mainly intended to involve energy-related problems and to reinforce math skills traditionally developed in the 8th grade. Ideally, we would like to see the science, math, and social studies teachers team up or coordinate teaching the three lessons in the AMERICA'S WOODEN AGE section. For the science teacher there are a series of experiments that help students discover the energy content in wood. These labs comprise the next section of this unit.

Extending the Learning

Ask students to write a diary of their own following the same format of the colonial farmer's diary. Students can then share their diaries and discuss the role of energy in their daily activities.

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Student Handout 5
Energy and Cultural Patterns: The Colonial Farm

Using the information from the diary, the picture of the farm family and the previous readings, complete the following questions.

1. What sources of energy were available to the settlers?
   (Wood, wind, animal and human power.)

2. The following tasks were done by the settlers. What source of energy was used for these tasks?

   a. Producing food
      (Animal and human muscle power.)
   b. Preparing food
      (Human muscle power and wood.)
   c. Building homes and barns
      (Animal and human muscle power.)
   d. Lighting and heating homes
      (Wood, oil lamps, tallow candles.)
   e. Preparing clothing
      (Human muscle power.)
   f. Making furniture
      (Human muscle power.)

3. List two jobs performed by each member of the family.

   a. Mother
      (Spins and cooks.)
   b. Father
      (Clears land, farms.)
   c. Children
      (Carry wood, fish.)

4. In the colonial period, what do you think made one family wealthier or better off than another?
   (The number of people who could work, the health and strength of the family members, the amount of land the family could cultivate.)

2. The Energy Content of Wood

Overview

After serving as the main source of fuel for many centuries, wood was largely abandoned when technology made fossil fuels more widely available. With the increasing importation and rising costs of fossil fuels, however, wood may again become a viable alternative fuel. This possibility is raised in this lesson as students examine the energy content of wood.

Objectives

Students should be able to:

1. Construct a can calorimeter.
2. Read a thermometer accurately.
3. Weigh a given amount of wood.
4. Determine the energy content of wood.
5. Measure heat in Calories.

Target Audience

Science.

Time Allotment

One-two class periods.

Materials

Class sets of:
- Lab Activity Sheet 1, "How Can We Find the Energy Content in Wood?," pp 73-75
- Lab Activity Data Sheet, p 76
- Lab Activity Sheet 2, "Data Tables 1 and 2," p 77
- Student Worksheet, "Problems on Calories," p 78

1 small cardboard juice can/metal bottom
1 stirring rod
1 larger juice can
1 ring stand with clamp
100 ml water
1 thermometer - 10°-110°C
wire screen
platform balance
woodshavings (different kinds)
graduate cylinder
matches

Background Information

In the years 1850-1860 it has been estimated that 17.5 cords of wood per year were used to heat the typical American home. (A "cord" is a stack of wood 1.2 x 1.2 x 2.4 meters.) Although wood is no longer an important fuel proportionately (compared to other fuels), large amounts are still burned.

Fuel values vary for different types of wood. Hardwood (oak) has more heating value than softwood, for example, pine. Heating values per cord of wood also vary greatly. For example, 1 kilogram of dry hardwood has about as much heating value as about half a kilogram of good coal.

Teaching Strategies

Opening the Lesson

Ask:

"What kinds of wood do you burn in your fireplace?

"Do you think all wood produces the same amount of heat? Why or why not?

Tell the students that they will now do a lab activity to determine the heat content of wood.

Developing the Lesson

Divide the class into small groups of 4-5 students each. Distribute the materials needed for the lab and the Lab Activity Sheet 1. Review the Lab Activity Sheet with the students. Then allow the students to do the lab and complete the Student Activity Data Sheet.

Concluding the Lesson

Students may be interested in knowing why there are different results even though they had the same mass of wood shavings. Ask what factors might explain the difference. Ask how the types of wood differed. Lead class to a generalization that shows resinous wood has greater heat content than non-resinous wood.

Extending the Learning

The following is offered for the benefit of students who may need some practice in working with calories. Use in conjunction with Lab Activity Sheet 2 and "Problems on Calories."

Refer to the math section (Lesson 3) if students are interested in determining how many Calories of heat are needed to heat their home.

1. Definitions:

   a. calorie: the unit used for the quantity of heat energy required to raise the temperature of 1 gram of water 1 degree Celsius.

   b. joule: the unit of energy or work supplied by a force of 1 newton applied for a distance of 1 meter.

   c. newton: a unit of force as 1 kg x 1 m/sec^2.

   d. Calorie: is equal to 1000 calories.

   Energy and work are interconvertible. Therefore, through conversion joules and calories are interchangeable as units of energy.

   Note: The Calorie that we talk about when we talk of the food we eat is a kilocalorie (1000 calories). It is usually referred to as the Calorie. The capital "C" designates the kilocalorie. So a piece of chocolate cake that is 500 Calories is really 500 kilocalories or 500,000 calories.

2. A calorie = heat unit

   = (mass of water in g) x (temperature change in degrees Celsius)

3. 1 calorie = 4.184 joules therefore

$$4.184 = (1\ g\ H_2O) \times (1^oC)$$

4. 1 Calorie = 4184 joules

5. $1\ \text{joule} = \dfrac{1\ \text{calorie}}{4.184}$

6. $1\ \text{joule} = \dfrac{\text{degrees} \times g}{4.184}$

Lesson 2 Lab Activity Data Sheet

1. Mass of water
100 ml = 100 g or = 0.1 kg

2. Mass of wood shavings
2.75 g

3. Temperature of H_2O before heating
13.5°C (may vary)

4. Temperature of H_2O after heating
50.0°C (may vary)

5. Temperature change of H_2O
(Numbers depend on wood type. 36.5°C, may vary.)

6. Heat gained by H_2O = temperature change x mass of H_2O x 1 Cal/g-c° =
36.5°C x .100 kg x 1 Cal/g-c° = 3.65 Cal

7. Heat content of wood = $\frac{\text{heat output}}{\text{mass of wood}}$ =
$\frac{3.65\ Cal}{2.75\ g} = 1.36\ Cal/g$

8. Percent difference = $\frac{\text{experimental results}}{\text{accepted value}}$ =
Sample Answer $\frac{1.36\ Cal/g}{2.76\ Cal/g} = .49 = 49\%$

9. Why was your value probably lower than the average value for wood?
(Answers will vary, but heat loss should be mentioned.)

10. How might you improve the design of this experiment?
(Accept all responses.)

Lab Activity Sheet 2 — Data Tables 1 and 2

DATA TABLE 1: Mixing Different Amounts of Water

Measure the amounts of hot and cold water. Find the temperature of each. Add the cold to the hot and measure the temperature of the mixture. *(Sample answers are shown.)*

Trial #	Hot Volume H_2O (ml)	Hot Temp. (°C)	Cold Volume H_2O (ml)	Cold Temp. (°C)	Temp. of Mix (°C)
1	50	*(60)*	50	*(5)*	*(33)*
2	75	*(61)*	25	*(11)*	*(48)*
3	90	*(62)*	10	*(14)*	*(57)*

Note: 1 g of water occupies 1 ml of space. Density or mass = 1.0g/ml. Find out how much the temperature changed in the above trials and complete the next table.

DATA TABLE 2: Calculating the Energy Changes

Trial #	Hot Mass H_2O (g)	Hot Temp. Change (Initial Temp. - Mix Temp.) °C	Hot (Mass x Temp. Change)	Cold Mass H_2O (g)	Cold Temp. Change (Initial Temp. - Mix Temp.) °C	Cold (Mass x Temp. Change)
1	50	*(60 - 33)* 27	*(1350)*	50	*(33 - 5)* 28	*(1400)*
2	75	*(61 - 48)* 13	*(975)*	25	*(48 - 11)* 37	*(925)*
3	90	*(62 - 57)* 5	*(450)*	10	*(57 - 14)* 43	*(430)*

Compare the Hot with the Cold.
(Answers about the same.)

Student Worksheet

Problems on Calories

1. How many calories are released when 250 g of water cools from 50°C to 30°C?
   (50°C - 30°C = 20°C temperature change
   20 x 250 = 5000 calories or 5 Calories
   or 20,920 joules.)

2. How many calories are needed to heat 350 g of water from 30°C to 70°C?
   (70°C - 30°C = 40°C temperature change
   40 x 350 = 14,000 calories or
   14 Calories or 58,576 joules.)

3. If 500 calories (2,092 joules), of energy are released from 50 g of water, how many °C will the temperature change?
   (500 ÷ 50 = 10°C.)

4. A tub of water loses 10°C in temperature and supplies 13,500 calories (56,484 joules) of heat to a room. How many grams of water are in the tub?
   (13,500 ÷ 10 = 1,350 grams.)

5. A small candle supplies 50 calories (209.2 joules) of energy each minute. How many minutes will it take to heat 100 g of water from 10°C to 35°C?
   (35°C - 10°C = 25°C temperature change
   25 x 100 = 2,500 heat
   2,500 ÷ 50 = 50 minutes.)

3. "Big Numbers" and Energy

Overview

Wood was the main source of heat energy in colonial America. The overriding purpose of this activity is to help students use the information provided by their own calculations to reinforce their understanding and to develop an increasing ability to work with large numbers. Basic skills involving powers of ten and scientific notation will be developed in a set of problems that use energy in wood as an organizer.

Objectives

Students should be able to:

1. Apply the principles of scientific notation to energy data.

Target Audience

Math.

Time Allotment

Two class periods.

Note: This lesson assumes that students have had experience in writing numbers in scientific notation, multiplying and dividing bases to powers and in doing operations using numbers written in scientific notation.

The NSTA packet, Mathematics in Energy provides lessons reviewing and explaining these ideas and skills.

Materials

Class sets of:

Student Handout 1, "Woody Problems," pp 79-80

Lesson 3 AMERICA'S WOODEN AGE

Student Handout 1

Woody Problems

1. A one-acre woodlot can produce 17×10^6 BTU's of energy per year. How many Calories are equivalent to the number of BTU's of energy in one acre of wood? (Note: There are .25 Calories in one BTU.)

   ($17 \times 10^6 \times .25 - 4.25 \times 10^6$ Calories or 17.78×10^9 joules of heat energy.)

2. There are 7.5×10^8 acres of woodland in the U.S. Using the findings in problem 1, how many Calories of fuel energy could the trees growing in the United States produce?

   {$(7.5 \times 10^8)(4.25 \times 10^6) = 3.19 \times 10^{15}$ Calories or 13.34×10^{18} joules of heat energy can be produced annually.}

3. A 19th century family used 17.5 cords of wood to heat an average size home for a year. At that time a one-acre woodlot produced about ½ a cord of wood annually. How many acres of wood did they need to produce the 17.5 cords they used? *(35)* How many BTU's did they use?

   (2.98×10^8)

4. Total available energy in U.S. forests is 300Q (300×10^{15} BTU's). How many years would this resource last if wood were used for space heating? (In 1978 the residential and commercial sectors used 29.3Q.)

   ($300 \div 29.3 = 10.24$ years.)

5. In 1978 Americans used 29.3Q to heat their homes and businesses. How many acres of wood would it take to produce that much energy?

   {$(29.3 \times 10^{15}) \div (17 \times 10^6) = (1.72 \times 10^9)$ acres needed.}

6. In a metropolitan area a cord of wood sells for $90/cord. One cord produces 17 x 10^6 BTU's. A fireplace is 10% efficient. What is the cost per million BTU's of room heat from a fireplace? An oil furnace is 70% efficient. A gallon of fuel oil costs about 65¢ and provides .14 x 10^6 BTU's of heat. What is the cost per million BTU's of room heat from an oil furnace? A wood stove is 75% efficient. How does the cost of wood fuel used in such a stove compare with oil?

{(17 x .1 = 1.7
$90 ÷ 1.7 = $52.94/$10^6$ BTU's

17 x 10^6 BTU = 18 x 10^9 joules
18 x .1 = 1.8
$90 ÷ 1.8 = $50/$10^9$ joules)

(.14 x .7 = .098
$0.65 ÷ .098 = $6.63/$10^6$ BTU's

.14 x 10^6 = .15 x 10^9 joules
.15 x .7 = .11
$0.65 ÷ .11 = $5.91/$10^9$ joules)

(17 x .75 = 12.75
$90 ÷ 12.75 - $7.06/$10^6$ BTU

18 x .75 = 13.5
$90 ÷ 13.5 = $6.66/$10^9$ joules)

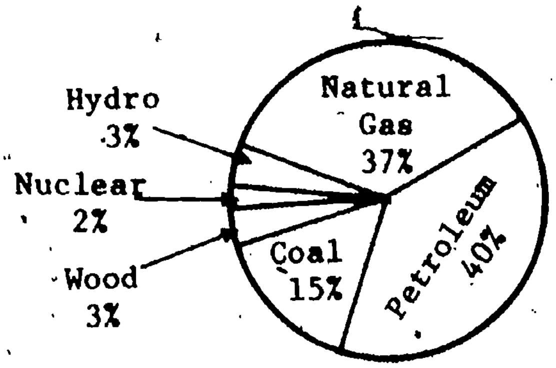
(Burned in a wood stove, wood is comparable to fuel oil.)}

Extra Credit Problem

7. Students may wish to do some research to determine the amounts of various types of energy used in the U.S. Find out how much of the total U.S. consumption was supplied by each energy source. Then draw a rectangle that represents total consumption. Divide the rectangle into squares representing some convenient value. Assign each block to an energy source in proportion to the amount of energy each source supplies. (This could also be hypothetical - a suggestion for wiser use of an energy source. Students may wish to present some of their findings to the class orally.)

(See next page for answer.)

(Percentages given in graph are suggested theoretical amounts. Answers will vary.)



Rectangle representing energy sources:

G	G	G	G	N/H
N/G	G	G	G	P
P	P	P	P	P
P	P	C	C	C

½ block for wood
3 blocks for coal
7½ blocks for natural gas
8 blocks for petroleum
½ block for nuclear
½ block for hydro

<u>Note</u>: *You may wish to use this problem for students needing a greater challenge. The research could constitute an extra credit project.*

Suggested Activity

Ask the students to bring an average size log to school. Weigh the log and multiply the number by 5 to determine the weight of an armload of wood. (Have students give answers in kilograms.)

2.2 lb = 1 kilogram

If one kilogram contains 2760 Calories (or 11,547,840 joules), how many Calories (or joules) of energy are in the armload of wood?

(The weight of an average size log is about 2.5 kg. Answers may vary.

5 x 2.5 = 12.5 kg -- approximate weight of an armload of wood.

12.5 x 2760 = 34500 Calories or 144.3 x 10^6 joules of energy in an average armload of wood.)

The Coming of Coal
(1840-1920)

4. Coal Comes of Age

Overview

Throughout the colonial and early national period, the vast resources of wood, water, animal and human power provided more than enough energy for the small, mostly agricultural population. But as the population grew, and as the Industrial Revolution introduced new technologies, the demand for energy increased dramatically. Coal, which had in earlier times been of use primarily to the blacksmith, replaced wood as the primary source of power for the new age of the steam engine. Coal had several advantages over wood. Unlike wood, which had been depleted in many areas, coal was in abundant supply. In addition, coal was more economical to transport since it had more calories per ton than wood.

This unit examines the transition from wood to coal and discusses the effect that this energy change had on the culture of the industrializing nation.

Objectives

Students should be able to:

1. List the reasons that coal replaced wood as the major source of energy after 1885.
2. Explain two effects of the energy change on the culture of the nation.
3. Interpret information from a graph.
4. Construct a graph from a set of data.
5. Develop and test an hypothesis.

Target Audience Social Studies.

Time Allotment Two-three class periods.

Materials

Class sets of:

- Student Handout 1, "Changing Fuel Sources in the United States," p 81, and Questions to Accompany Student Handout 1, p 82
- Student Handout 2, "Growth of Railroads," p 83, and Questions to Accompany Student Handout 2, pp 84-85
- Student Handout 3, "Making a Pictograph," p 86
- Student Handout 4, "Production of Steel Ingots and Castings in the U.S.," p 87, and Questions to Accompany Student Handout 4, p 88
- Student Handout 5, "Electricity Consumed in the U.S.," p 89, and Questions to Accompany Student Handout 5, p 90
- Student Handout 6, "Population of the U.S.," p 91

Teaching Strategies

The students examine a graph showing changes in energy sources. They are asked to develop tentative hypotheses about why this change occurred. Students examine three pieces of data. Student hypotheses are tested using this data.

Introducing the Lesson

Ask the students to name the types of energy that they use. Ask them why they use the types of energy they named. *(Some of the answers could be that that is all they have; it's the only kind available. They need oil to run cars or heat their homes.)* Ask what changes in the economy or culture would make them change the type of energy they use.

Tell the students that this unit studies an historical period from 1860 to 1920. The students' task is to find out why energy sources changed during that period and what effect this had on the culture of that time period.

Student Handout 1

Forming a Hypothesis

Distribute copies of Student Handout 1, "Changing Fuel Sources in the United States." Have students examine the graph and answer the questions.

After examining the graph and answering the questions, ask the students why they think this change occurred. Direct their answers to other factors in a culture such as population changes and new industries. Point out to the students that they are making educated guesses about the relationship between two things. This is an hypothesis. List these hypotheses on the board.

During this part of the lesson, do not have the students discuss each other's hypotheses. After the hypotheses are listed, you might have the class decide which three or four are most likely to be true. Then have the class make a list of possible data or information they would need to support their hypotheses.

Some of the students' hypotheses might call for data or information that are not provided in the package. For example, a student might say that the nation changed from wood to coal because the nation ran out of wood. This is incorrect because, unlike the British Isles, where wood was greatly depleted, it was scarce in the U.S. only near heavily populated areas. Direct the student to a reference book to find out the total amount of available wood or the amount of virgin or reforested wood.

Each student could be given the assignment to bring in a piece of information, chart, graph, etc. from home.

Student Handout 1
Questions and Answers

This graph shows the changes in the major energy sources in the United States.

1. In what year did wood make up over 80% of the energy used in the U.S.? *(1860.)*

2. In what year was energy supplied equally by wood and coal? *(1885.)*

3. In what year did coal reach its peak of importance as an energy source? *(1920.)*

4. Based on this graph, what period of time would you label "The Age of Coal?" Why? *(Answers may vary. 1885-1940 is the time period when coal made up over fifty percent of the energy used in the U.S.)*

The rest of this unit deals with the question of why coal rose and then fell in importance. Before going on to the other lessons, list as many reasons as you can for this change. When you have finished the unit, look back on this list. Make whatever changes you feel necessary.

Student Handout 2
Graphs A & B

Growth of Railroads. Students examine two graphs and answer questions.

Student Handout 3
Making a Pictograph

Students construct a pictograph showing different amounts of railroad track.

Student Handout 4

Growth of steel. "Production of Steel Ingots and Castings in the United States." Students answer questions and then relate this graph to the graph on railroad growth.

Student Handout 5

"Electricity Consumed in the U.S." Students answer questions related to this graph.

Student Handout 6
Population of the United States

Students answer questions and construct a graph from this table and then relate the data to railroad and steel production and energy use.

After examining the data, ask students to refer back to their hypotheses. Ask if the data support their "educated guesses." What other information would they need to be more sure of their hypotheses?

At the conclusion of the lesson, have students write a brief paragraph explaining the relationship between the growth of coal and the other factors discussed.

Special Note

The lesson is designed to reinforce data interpretation. This takes time. If students have particular difficulty, you could have them examine the chart on railroad growth. Have the students relate just this piece of data to their hypotheses.

Student Handout 2

Look at graphs A and B which are called bar graphs. Then answer the following questions.

1. What do the horizontal lines in both graphs tell you?
   (The years covered in the graphs.)

2. What time period is covered by the graphs?
   (1840-1920.)

3. What does the vertical axis show in Graph A?
   (The total amount of railroad track in the country.)

4. What does the vertical axis show in Graph B?
   (The amount of railroad track built each year.)

5. How many miles of track were there in 1860? *(Just over 20,000.)* In 1870? *(Just over 40,000.)* In 1920? *(About 370,000.)*

6. How many new miles of track were built in 1860? *(1,500.)* In 1870? *(5,500.)* In 1920? *(About 250.)*

7. Write a statement showing the trend in railroad growth between 1840 and 1920 in the United States.
(While the amount of new track varied, the total amount of track rose continuously.)

8. Write one or two sentences showing the differences between the two graphs.
(Graph A shows total amount of track and Graph B shows only the new track.)

Student Handout 3

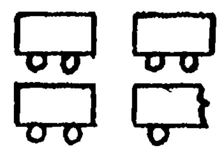
Making a Pictograph

You have looked at two graphs showing railroad growth. Now you are to make a new type of graph. The graph is called a pictograph. Pictures are used to show different amounts of railroad track.

The title of the graph is "New Miles of Railroad Track Built in the U.S." Be sure to use the correct graph from Student Handout 2 to complete your pictograph.

To make things easier, round off the numbers to the nearest hundred. For example, 620 or 649 becomes 600. If the number ends with 50 or more, raise the number to the next hundred. For example, 650 rounds off to 700.

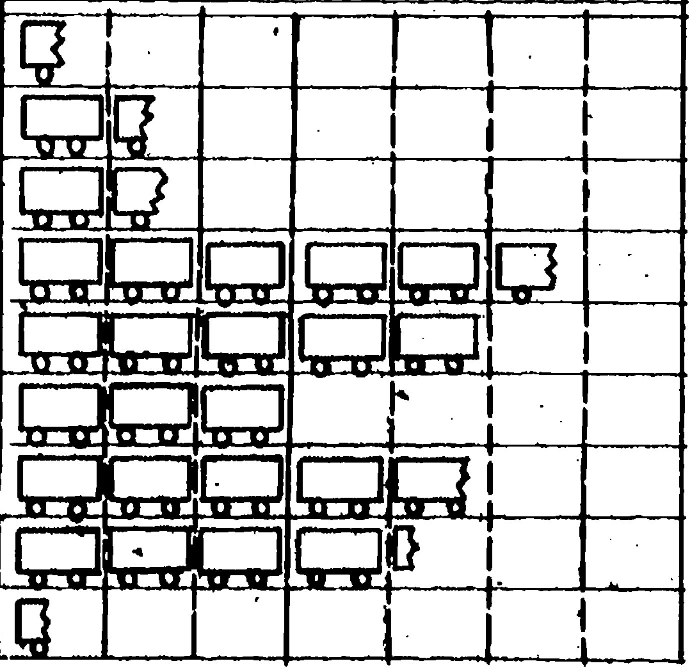
On this graph, each railroad car represents 1000 miles of track. You must estimate what fractional part of a car you will need to draw to show some numbers. Look at the examples below.

2,000 - 

1,600 -

Now fill in this chart: (One is already done for you.)

Year	Miles of New Track	Round off to nearest hundred	Pictograph (Use one column for each car or part of car)
1840	606	600	
1850	1,261	1,300	
1860	1,500	1,500	
1870	5,658	5,700	
1880	5,006	5,000	
1890	3,000	3,000	
1900	4,894	4,900	
1910	4,122	4,100	
1920	314	300	



Look at the pictograph that you have just completed. What ten year period showed the greatest growth in railroad production?

a. 1850 to 1860 b. 1860 to 1870 c. 1880 to 1890

Questions to Accompany Student Handout 4

PRODUCTION OF STEEL INGOTS & CASTINGS
IN THE UNITED STATES, 1840-1920

1. What kind of graph is this?
   (Bar graph.)

2. What does the vertical axis show?
   (Tons of steel produced.)

3. What does the horizontal axis show?
   (Years.)

4. What period of time is covered on this graph?
   (1840-1920.)

5. When was steel first produced in this country?
   (1870.)

6. Between what years was there the greatest jump in the production of steel?
   (1900-1910.)

7. What trends do you see in the production of steel in this time period?
   (The production of steel increased every decade.)

8. After examining the chart on steel production, look back at the graph on railroad growth. What similarities and differences do you see?
   (Steel production began in the decade that railroads had their greatest growth 1870-1880. Steel production continued to grow after railroad production leveled off and declined.)

9. What is the relationship between steel production and railroads?
   (Steel is necessary for track and for the railroad cars and engines.)

10. What is the relationship between steel production and coal?
    (Coal is needed to make steel.)

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Questions to Accompany Student Handout 5

ELECTRICITY CONSUMED IN THE U.S.

1. What does the vertical axis show?
(Vertical axis shows million kilowatt hours. However, note that a kilowatt hour is a unit of work or energy resulting from the use of 1 kilowatt of power in one hour. It is equivalent to 853 Calories {3,568,952 joules} of heat energy.)

2. What does the horizontal axis show?
(The horizontal axis shows the years from 1900 to 1930 in five year intervals.)

3. What is the general trend depicted in the bar graph?
(A steady increase in the growth of electrical energy consumption from 1900 to 1930.)

4. How many millions of kilowatt hours were consumed in the U.S. in 1905?
(About 15,000 million kilowatt hours.)

5. How many millions of kilowatt hours were consumed 20 years later?
(About 85,000 million kilowatt hours.)

6. List as many reasons as you can for the increased consumption of electricity during the period included on the graph.
(Answers will vary. However, possible choices should include growth of population, increased availability of fossil fuel sources, a rise in demand for electricity for home heating and for industrial processes.)

Student Handout 6

Population of the United States

1850	23,261,000
1860	31,513,000
1870	39,905,000
1880	50,262,000
1890	63,956,000
1900	76,094,000
1910	92,407,000
1920	106,461,000

1. What trend do you see in the population?
   (Population increased every year.)

2. What is the relationship between a growing population and the need for coal?
   (A larger population would need a greater supply of energy.)

3. Use the data in the table to make a graph. You can make a bar graph or a pictograph. Be sure to label the vertical and horizontal axes. Give your graph a title.

Concluding the Lesson

Ask the students to think about the difference that the growth of railroads, the increased production of steel and the growth of population made on the culture. The students could write a brief story about "The Coming of the Railroad to a New Town."

What were some of the advantages that the railroad brought? What were some of the disadvantages?

5. How Coal is Formed and How It's Used

Overview

Coal is the most abundant fossil fuel in the United States. This lesson is designed to give the students an understanding of the formation of coal, and how coal is used to produce electricity.

Objectives

Students should be able to:

1. Explain the formation of coal in a series of pictures.
2. Trace the route of energy from coal - beginning with the earth and ending with a plug in the wall.
3. Make a model of a steam turbine.
4. Explain how electricity is produced.
5. Discuss the causes of the increase in electricity consumption.

Target Audience

Science.

Time Allotment

Three-four class periods.

Materials

Class sets of:

- Student Handout 1, "How Coal Was Formed," p 93
- Student Handout 2, "Tracing Coal," p 94
- Student Handout 3, "A Working Model of a Steam Turbine," pp 95-97
- Student Handouts 4A and 4B, "Producing an Electric Current," pp 98-99
- Student Handout 5, "Power Generating Plant," p 100

bar magnet and U magnet
cardboard tube
copper wire
galvanometer
large orange juice can with metal bottom
metal top from larger juice can
tin shears
small strip of metal or support for the tin disk
cork
medicine dropper
test tube
support rod
needle
thimble
scissors
pencil/eraser
manila circles
ruler
compass
Bunsen burner
one hole stopper
metal glue
screw

Teaching Strategies

Probably the best way to introduce this lesson is to get a piece of coal and show it to the students. If you can't get a sample, show a picture of coal. Ask the students to describe coal. Lead into the gist of the lesson by asking:

> "Did you know that it takes a large stack of rotted plant and animal life forms, millions of years, and pressure to make a layer of coal?"

Developing the Lesson

Student Handout 1

Distribute the pictures of coal formation. Then ask the students to write several sentences - at least one for each picture - that describe how coal is formed. Allow sufficient time for students to complete this activity. Later discuss their descriptions in class.

Student Handout 2

The focus of this activity is to have students trace coal and its energy from the mine site to a plug in the house wall. Distribute the scrambled pictures on Student Handout 2. Then suggest to your students that they put the pictures in correct sequence, using the numbers to identify each picture. Discuss the proper sequence in an informal class discussion period. *(Sequence: 5,2,3,7,1,8,4,6.)*

Special Note

> Student Handouts 1 and 2 may be combined.

Student Handout 3

Ask your students to explain in their own words what they think happens in a power plant. What makes steam? What does the steam do? How is electricity produced?

Student Handout 4

Discuss how the potential energy in coal is converted to electrical energy at the power plant. Then have your students complete Activities 4A and 4B, "Producing an Electric Current."

Special Note

> Consider setting up activity centers for Student Handouts 3 and 4.

Student Handout 5

Discuss the relationship between the models that the students made and the picture of the power generating plant. Have the students identify each of the parts of the plant and discuss the relationship of that part to the next. For example, coal is used to produce steam which turns the turbine which turns the generator to produce electricity.

Depending on the ability of the students, you may wish to discuss how one form of energy is being converted to another form of energy during this process.

Questions and Answers

Compare each part of the picture to the models you have made. *(Furnace-B burner; boiler-test tube; turbine-hand-made turbine; fuel supply-natural gas; condenser/cooling pond-no equivalent; generator-coil and magnet.)*

Based on the picture and your models explain the step by step method of how coal is used to make electricity. *(Coal is burned in the furnace; the heat boils water; steam turns the turbine, then is cooled, condensed and reheated. The moving turbine powers the generator, and the generator produces electricity.*

Extending the Lesson

Go back to Lesson 4, using Student Handout 5, and relate the increase in the availability of coal to the increase in electrical consumption from 1900 to 1930.

Oil: Bright Promise
(1880-present)

6. New Promise, New Problems

Overview

This is the third part of this unit on energy transitions in history. This lesson focuses on the reasons for the shift from coal to oil as the primary energy source and the effects that this change had on the cultural patterns of the nation. The role of oil and oil-based products in the nation today is discussed.

Objectives

Students should be able to:

1. List reasons for the development of oil as the primary source of energy in the United States.
2. Explain the effects of oil-based industries on the present American culture.
3. Read, interpret and draw conclusions from prepared sources.
4. Categorize data.

Target Audience

Social Studies.

Time Allotment

Three-four class periods.

Materials

Class sets of:

Student Handout 1, "Oil-Based Products," pp 101-102

Student Handout 2, "The Development of Oil," pp 103-105, and Questions to Accompany Student Handout 2, p 106

Student Handout 3, "U.S. Production of Crude Oil and Total Consumption of Petroleum," p 107

Student Handout 4, "U.S. Oil Imports," p 108

Student Handout 5, "Crude Oil Prices in Arabian and Persian Gulfs," p 109, and Questions to Accompany Student Handouts 3-5, pp 110-111

Developing the Lesson

Ask students to name things that are made from oil. List these on the board.

Student Handout 1

Distribute class copies of the list of products related to oil. Allow enough time for the class to examine the list.

Working alone or in small groups have students categorize the items as necessities or luxuries.

After the students have categorized the items, tell them that the amount of oil available in the country has been cut in half. They must eliminate half of the items on the list.

After they have done this, ask them how the decision was made to cut the list in half. What did they consider absolute necessities? What did they consider luxuries? Why do students have different answers?

Student Handout 2

Have students read Student Handout 2, "The Development of Oil," in the Student Guide and answer the questions.

Questions to Accompany Student Handout 2

THE DEVELOPMENT OF OIL

1. Was oil valuable to the people in the United States around 1800?
   (Oil had limited value. It could be used for medicine, sealing and lighting.)

2. Was oil used as an energy source before 1800?
   (Only for some lighting.)

3. Why did farmers dislike finding oil?
   (The farmer had little use for oil and it damaged the soil for farming.)

4. List three reasons why the demand for energy increased between 1820 and 1920.
(Possible answers: Growth of population, growth of cities, growth of factories, changing lifestyle, increased transportation.)

5. Why did investors put their money in oil development after 1850?
(They thought they could make a profit by producing oil.)

6. What does the term "energy intensive" mean?
(A lot of energy is used in the production process.)

7. What did people mean when they called the drilling project "Drake's folly?"
(People thought that he was wasting his money.)

8. In the last paragraph, why is striking oil compared to a gold rush?
(Possible answers: By 1859 the value of oil had increased, it was a valuable resource.)

Student Handouts 3-5

Have students examine the graphs, "U.S. Production of Crude Oil and Total Consumption of Petroleum," and "U.S. Oil Imports," and "Crude Oil Prices in Arabian and Persian Gulfs." Then have them answer the questions. Questions 14 and 15 can be handled as discussion questions.

Questions to Accompany Student Handouts 3-5

1. What is the title of Graph #1?
   (U.S. Production of Crude Oil and Total Consumption of Petroleum.)

2. What does the vertical axis show?
   (Billions of barrels.)

3. What does the horizontal axis show?
   (Years.)

4. What is the time span of the graph?
   (1950-1977 or 27 years.)

5. What is the trend in total consumption?
   (Increasing at a rapid rate.)

6. What is the trend in crude oil production?
   (Growing until 1970, then decreasing.)

7. Between which years were total consumption and crude oil production growing at about the same rate?
   (1950-1955, 1965-1970.)

8. In which years were total consumption more than twice as much as crude oil production?
   (1973, 1974, 1975, 1976, 1977.)

Bonus Question

Where does oil come from that is not produced in the United States?
(It is imported from the Middle East, Canada, South America and Africa.)

9. What does Graph #2 show?
   (It shows the percentage of oil that the U.S. imports in relation to total consumption.)

10. What percent of the oil used in 1966 in the United States was imported?
    (9%.)

11. What percent of the oil used in the United States in 1976 was imported?
(41%.)

12. What does this graph show about the relationship between U.S. production of crude oil and total consumption of
(Not enough to meet demand.)

13. Look at Graph #3. What can you learn from the graph?
(That the price of oil from the Middle East has risen sharply in the last 5 years.)

14. Using the three graphs in this section, what reasons can you give for the rise in the price of

(Production and consumption are imbalanced. U.S. consumption is increasing steadily while production is decreasing which forces the U.S. to import oil regardless of the price.)

15. What effects do you think the rising price of oil will have on the U.S. culture and economy?
(Answers will vary. Use the question as a discussion starter.)

7. The Energy Content of Oil

Overview

This lesson is designed to provide students with an understanding of the energy content of oil.

Objectives

Students should be able to:

1. Determine the heat content of oil.

Target Audience

Science.

Time Allotment

One-two class periods.

Materials

Class sets of:

Lab Activity Sheet 1, "Heat Content of Oil," pp 113-114

Lab Activity Data Sheet, p 115

fiberglass insulation	can opener
glass stirring rod	3-in-1 oil
Bunsen burner	platform balance
ring stand with clamp	screen wire
small juice can with metal bottom	scissors
	matches
thermometer (40°-150°)	large metal juice can

Teaching Strategies

Introduce the lab activity which will show the energy content of a hydrocarbon (oil). (Note: Remind students that igniting the oil will produce a black smoke at first. This will soon subside.)

Developing the Lesson

Distribute the Student Handout 1 and materials for this lesson. Note: Fiberglass insulation can easily be obtained from a lumber yard or hardware store. However, instead of using fiberglass insulation, you may want to use ashes. Put ashes in a baby food jar lid and then add 3-in-1 oil.

Extending the Lesson

Compare the energy content of wood (Lesson 2) to that of oil.

Lab Activity Data Sheet *(All answers approximate.)*

1. Mass of water __100__ ml = __100__ g or __.1__ kg.

2. Temperature of water before heating __16.5__ °C.

3. Mass of screen stand, fiberglass and oil before heating __1.5__ g.

4. Mass of screen stand, fiberglass and oil after heating __1.2__ g.

5. Mass of oil __.3__ g or __.003__ kg.

6. Temperature of water after heating __35__ °C.

7. Change in water temperature __18.5__ °C.

*8. Heat gained by water = temperature change x mass of water x .001 = __1.85__ Calories or __7740.4__ joules.

9. Heat content of oil =

$$\frac{\text{Heat output (heat gained by } H_2O\text{)}}{\text{Mass of oil}}$$

$$= \frac{1.85\,Cal}{.003\,kg} = 6{,}167\ Cal/kg$$

**10. Accepted value for heat content of oil is __10,800__ Cal/kg or __45.19__ megajoules/kg.

11. % difference = $\frac{\text{experimental result}}{\text{accepted value}}$ = __.57__

$$\frac{6{,}167\ Cal/kg}{10{,}800\ Cal/kg} = .57 = 57\%$$

*To change calories to kilocalories (Calories) multiply by .001.

**Data taken from Energy and the Environment, by John M. Fowler, McGraw-Hill Book Company, p. 427, 1975.

ENERGY TRANSITIONS IN UNITED STATES HISTORY

Pre-Post Test

WOOD HYDROELECTRIC COAL OIL GEOTHERMAL NATURAL GAS

1. Which of the above was a primary source of energy during the following periods of U.S. History?

   a. The Colonial Period? *(wood)*

   b. The period from 1820 to 1900? *(coal)*

   c. The period from 1900 to the present? *(oil)*

2. Which of the following is not a unit of energy measurement?

   a. BTU

   b. joule

   c. watt

   d. calorie

3. Name three commonly used items that require oil to manufacture.
   (See list on pp 101-102.)

4. Who was Edwin Drake?

   a. He invented the gasoline engine.

   b. He drilled the first oil well.

   c. He founded U.S. Steel.

   d. He was the captain of the first steamship.

5. List two reasons why the demand for energy sharply increased from the period 1820 to 1920.
   (Growth of population, development, increase in transportation, more demand for consumer goods.)

6. The amount held by an average freight car is:

   a. equivalent to a gallon of gas.

   b. a stack measuring 4 x 4 x 8 ft.

   c. the amount that can be carried on the back of a strong donkey.

   d. the amount burned in the average fireplace in a week of continuous use.

7. What's wrong with this idea?

"In order to conserve its precious supplies of fossil fuels, the U.S. should switch from coal and oil to electricity."

(Most electricity generated by burning fossil fuels.)

8. *Reproduce Graph #2, Student Handout #3, Oil Lesson, "U.S. Oil Imports."* The statement that can be drawn from this graph is that:

   a. The U.S. has stopped drilling for oil.

   b. Americans are using less electricity.

   (c.) Oil imports steadily increased from the period between 1960 and 1977.

   d. Americans paid more for oil in 1977 than in 1960.

9. What does "OPEC" stand for?

   (a.) Organization of Petroleum Exporting Countries.

   b. Oil Producing Energy Cartel.

   c. Operational Plan for Energy Conservation.

   d. Organization for the Promotion of Environmental Controls.

10. A "turbine"

   a. converts mechanical energy to chemical energy.

   (b.) converts heat energy to mechanical energy.

   c. converts mechanical energy to electrical energy.

   d. converts chemical energy to mechanical energy.

11. *Reproduce picture on page 100 without labels.*

   a. This picture shows:

   -- the process of cooling hot water created when electricity is generated.

   (--) the generation of electricity from fossil fuels.

   -- how a boiler works.

   -- the path that electricity takes through a power plant.

b. Using the following terms, label the parts of the system: fuel supply, cooling pond, furnace, boiler, turbine, condenser, generator.

c. This system would most likely be found:

-- in a factory.

(--) in a power plant.

-- in a house.

-- aboard a ship.

12. *Reproduce picture on page 98, "Producing an Electric Current."*

a. This picture demonstrates:

(--) how an electric current is generated.

-- how a magnet works.

-- how a galvanometer works.

-- how a meter can be used as a compass.

13. Which of the following statements best explains the relationship between the growth of railroads and the increase in the use of coal during the same period of U.S. history?

a. These developments are entirely coincidental.

(b.) Coal was used to fuel locomotives and to manufacture rails.

c. Railroads were used to transport coal.

d. Railroad lines were owned by the coal companies.

14. The term "energy intensive" is used to designate:

(a.) process and manufactured goods which require large amounts of energy.

b. a process that requires an energy source having a high "energy per pound" ratio.

c. a power plant that produces electricity for industrial purposes.

d. energy sources which cost more than the goods and services produced by using them.

15. Which of the following statements best explains why coal replaced wood as a primary source of energy for the U.S.?

a. Coal was less expensive than wood.

b. The U.S. was running out of wood.

c. Coal mining provided greater employment opportunities than wood cutting.

(d.) Coal was easier to transport and contained more energy per pound than wood.

16. A "generator":

(a.) converts mechanical energy to electrical energy.

b. converts heat energy to mechanical energy.

c. converts electrical energy to chemical energy.

d. converts chemical energy to heat energy.

17. The formation of coal requires:

a. hundreds of years.

b. thousands of years.

(c.) millions of years.

d. This depends upon the level of technology.

Student Guide

Student Handout 1

The Death of Trees

Until the Elizabethan days (the days when Elizabeth I was the Queen of England), there had been a very low level of energy use throughout England. There was enough fuel for everyone to help themselves and move when supplies ran out.

The fuel was wood, and wood was everywhere. Whole forests covered the home counties. It needed no processing. It provided for all the needs in the home and for the few young industries that existed then. No one noticed the sharp rise in energy demand and the sharp rise in wood consumption (use) until the wood began to run out.

By the 1550's, the woods of several counties were all used up, and the ground had been converted to pasture...more and more remote forest areas were opened up and used up, and as supplies shrank, the growing industries moved out after them. Iron works were set up in the middle of forests.

When even the forests of Scotland were destroyed and supplies came to an end, what followed came close to a national disaster. Over whole areas of the British Isles the use of wood for heating homes died out because there was barely enough fuel for cooking...most of the population lived at subsistence level or starved. This was the energy supply situation.

"The Death of Trees,"
An Index of Possibilities,
John Chesterman, et al.
Pantheon Books, New York,
1974, p. 92.

Questions to Accompany Student Handout 1

THE DEATH OF TREES

1. Of what place and what time does this account tell?

2. What was the most widely used fuel at this time? Why was it such a good source?

3. What were some of the uses of wood during this time?

4. According to the reading, what did the people do when the local supply of wood ran out?

5. Why was there no attempt to conserve (save) forests at this time?

Thinking It Over

6. Although some people suffered when industry used forests, some people benefited. Compare the drawbacks and the benefits of sharing the primary source of energy with the new industries.

7. How is the energy situation today similar to England's in the past?

Student Handout 2

The Indian View of the Pilgrim Landing

"Grandfather," said the small Indian lad, "I have been to Plymouth. What happened there?"

The chief spoke softly and sadly. "I asked you not to go there, but now that you have...I shall tell you the story."

"I was a small boy when the white men came to our land. I saw the small speck at sea become a huge canoe with white blankets to catch the wind. Then the white men landed. What a strange sight they made! As we watched from the forest, we wondered why they had come. We watched them chop down our trees. Some of the braves said that it looked like they had come only for firewood and would soon leave. At first they seemed to be afraid of us. They told us there would be land enough for us all, and we could live side by side like brothers. We signed a peace treaty with them and taught them how to plant corn. Without us, their village would have failed the first year."

Inquiry USA
Ralph Kane and Jeffrey Gover,
Globe Book Company, New York,
1971, pp. 13-14.

William Penn: The New Land

The soil is even richer then we had hoped. Even the poorest places produce large crops of vegetables and grain. We produce from thirty to sixty times as much corn as in England.

The land requires less seed to produce a crop than in England.

We also find everything that grows well in England grows well in the colony - corn, roots, wheat, barley, oats...onions, garlic and Irish potatoes.

Our cattle fatten up for the market on weeds, and there is plenty of hay for the winter from our swamps and marshes.

Questions to Accompany Student Handout 2

THE INDIAN VIEW OF THE PILGRIM LANDING and WILLIAM PENN

1. The chief spoke of a huge canoe with white blankets. What did he mean?

2. Why was the chief sad?

3. What uses did the Indians have for the forests?

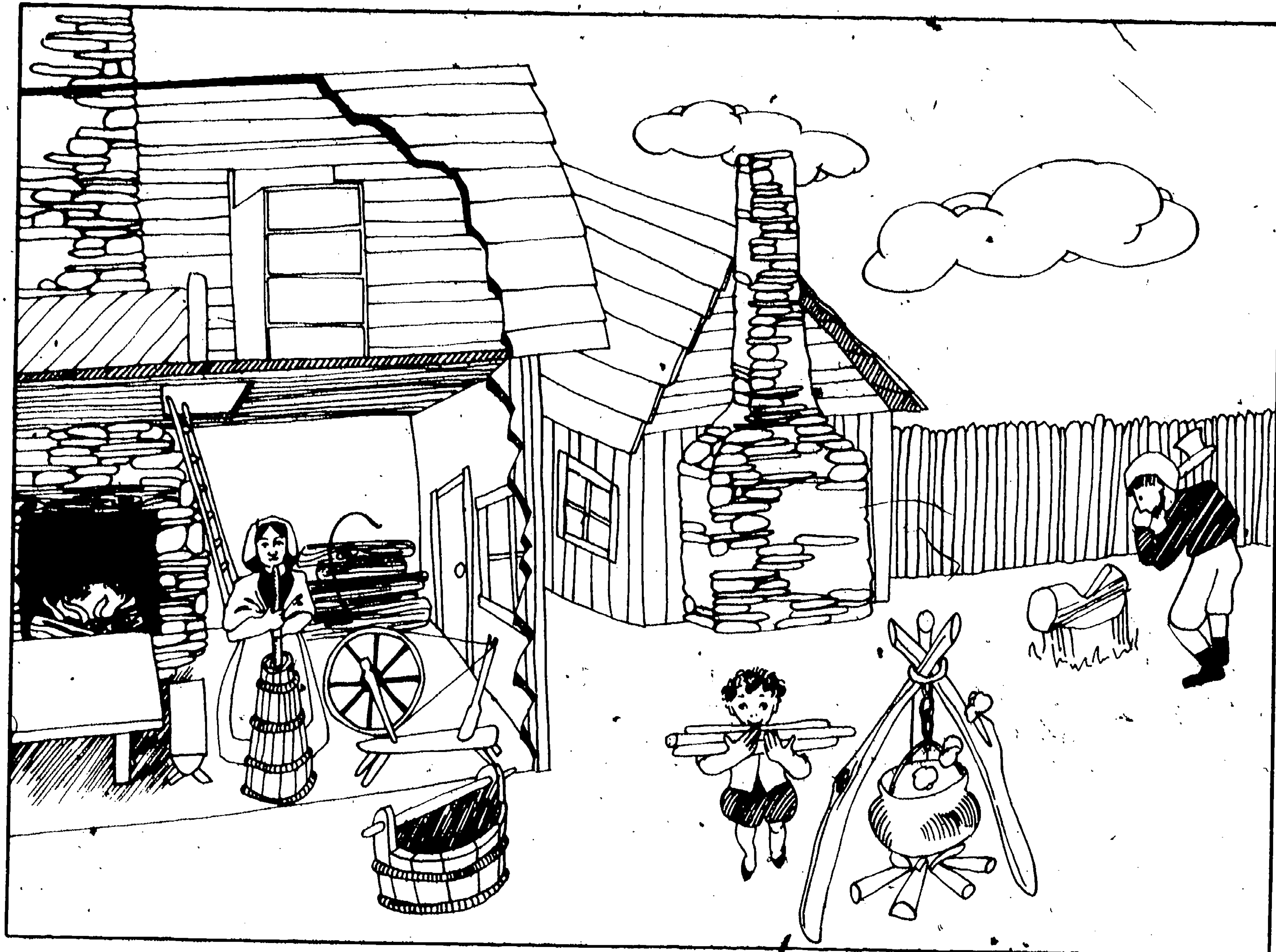
4. Why was William Penn so happy with the land in the New World?

5. Why do you think the settlers cut down the trees?

6. Compare the attitudes of the Indian Chief with William Penn about the use of land and trees.

Student Handout 3

Domestic Energy Use



Questions to Accompany Student Handout 3

DOMESTIC ENERGY USE

1. What are the uses of wood in the picture?

2. What are examples of energy being used in the picture?

3. What objects show that human muscle power was used to produce the necessities of life?

4. Why were wood and human energy used more in the colonial period than today?

Student Handout 4

Diary of a Colonial Farmer

Read the selection below. Then fill in the chart using the information from the diary.

5:00 am	Got up and fed the oxen, pigs and chickens. Wife started fire and cooked breakfast. A cold morning. Frost everywhere. Milked the cow.
6:00 am	Ate pork and buttered cornbread for breakfast. Have to make another chair so our youngest child will have a place to sit. Maybe I can do it tomorrow.
7:00 am	Hitched up the oxen to the plow. Started to plow half our field. Will have to get ready to plant wheat and corn. Hope to finish plowing before next week.
11:00 am	Weather finally warmed up some. Wife and children spent the morning preparing the garden. Soon the time will come to plant onions, lettuce and cabbage.
12:00 pm	Finally had lunch. Still thinking about making that needed chair. Had salted pork, and cornbread for lunch.
12:30 pm	Went back to plowing. After cleaning up the lunch dishes, wife spun thread. We all need some new clothes for the summer. I'm thinking about trading a pig for new shoes for the family. Haven't got time to make shoes. Children finally got to go fishing.

Diary of a Colonial Farmer (continued)

3:30 pm	Went to work on the fruit trees. Hope the blackbirds don't eat too much of the fruit this summer. Had to cut off all the dead limbs. Only worked on some of the trees. Too tired to trim them all. Had hoped to remove some tree stumps from the field. Maybe I can get to that before too long. Neighbor Thomas will help. Last week I helped him pull up stumps. Wife began to prepare supper. I'm glad children caught fish. We'll have them for supper with some boiled potatoes.
5:00 pm	All of us had supper. Still thinking about making that chair. Wife and children got supper dishes cleaned up. Children brought in some fire-wood. I milked the cow and fed the livestock again.
7:00 pm	Started to get cold again. Said evening prayers and children went to bed. Wife mended. I cleaned my rifle. Reminded myself to get wood for the chair I must make.
8:30 pm	Used the remaining light from the fire to write in my diary and read the Bible.
9:15 pm	So tired. Went to bed.

"The Life of the Farmer," <u>The Americans</u>, Edwin Fenton, editor, Holt, Rinehart and Winston, New York, 1975, pp 45-46.

Energy and Cultural Patterns: The Colonial Farm

Using the information from the diary, the picture of the farm family and the previous readings, complete the following

1. What sources of energy were available to the settlers?

2. The following tasks were done by the settlers. What source of energy was used for these tasks?

   a. Producing food

   b. Preparing food

   c. Building homes and barns

   d. Lighting and heating homes

   e. Preparing clothing

   f. Making furniture

3. List two jobs performed by each member of the family.

   a. Mother

   b. Father

   c. Children

4. In the colonial period, what do you think made one family wealthier or better off than another?

Lesson 2 — **America's Wooden Age**

Lab Activity Sheet 1

How Can We Find the Energy Content in Wood?

Materials (per group)

1 small cardboard juice can with metal bottom
1 large juice can
1 ring stand with clamp
100 ml water
wire screen
1 thermometer
1 platform balance
1 glass stirring rod
wood shavings (different kinds)
graduated cylinder
matches

Procedure

(Note: To aid in setting up the apparatus - see diagram on next page.)

1. Cut a piece of screen wire as shown in diagram (next page).

2. Bend the legs of the wire down and the sides up - this will prevent the wood shavings from falling off.

3. Weigh 2.75 grams of wood shavings and carefully place them on the wire basket.

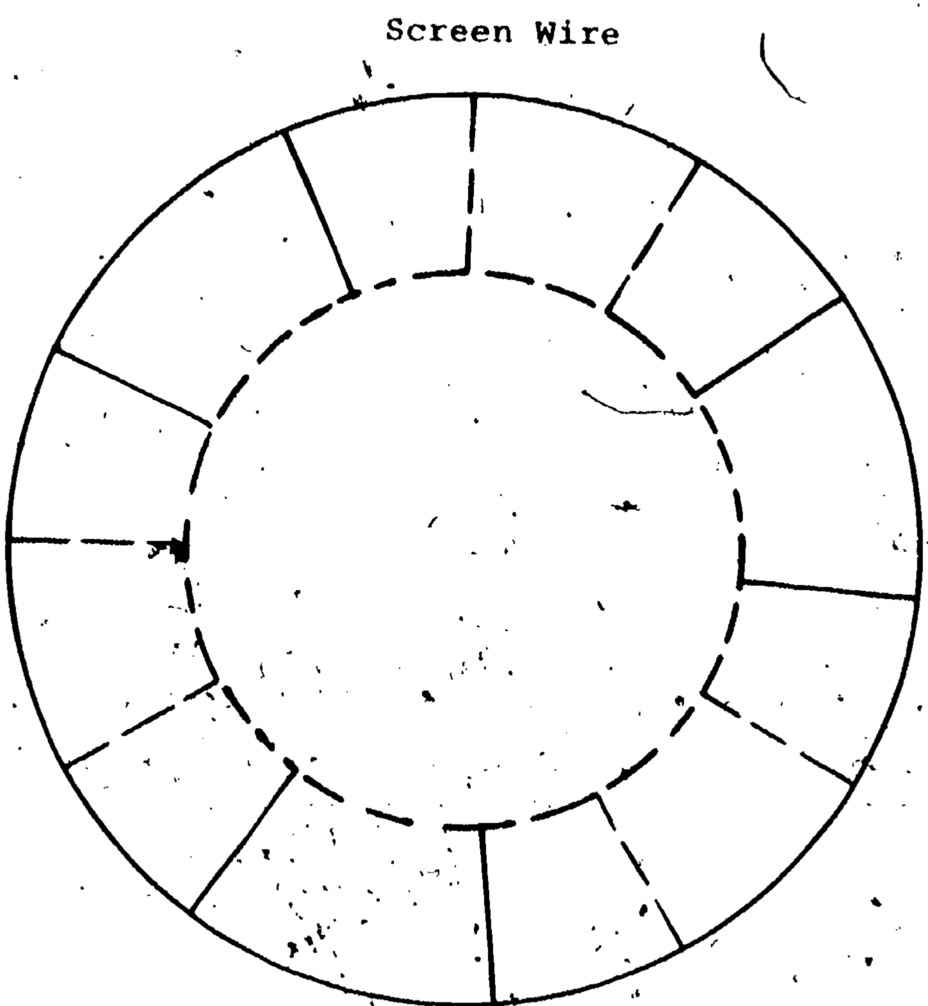
4. Set 2 match heads in the wood shavings (for easy lighting).

5. Punch 2 holes in the sides of the small juice can near the top rim. Put the glass stirring rod through these holes. Attach a ring stand (see diagram).

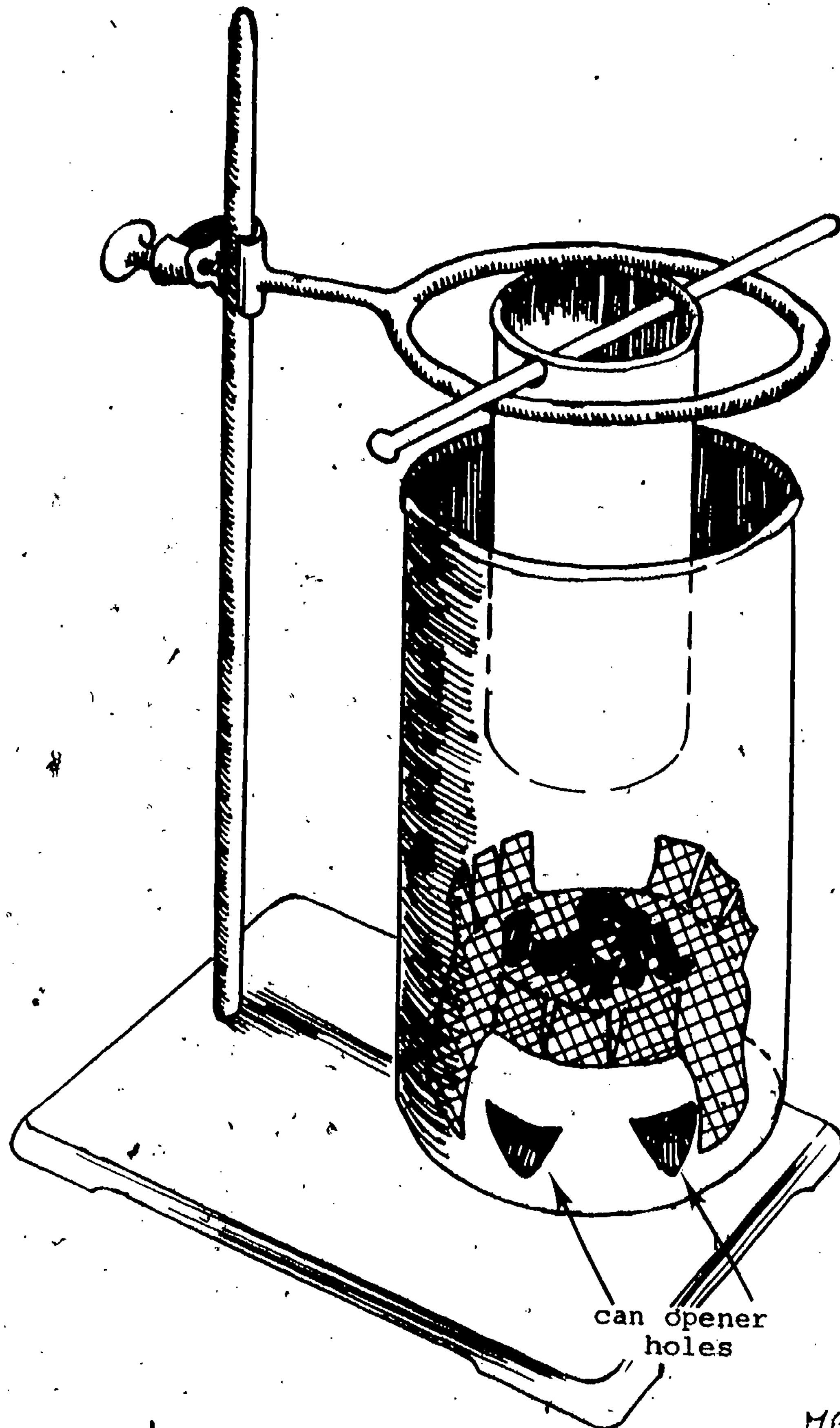
6. Measure out 100 milliliters of water. Put it into smaller can (1 ml of water = 1 g or .001 kg). Record on data sheet.

7. Take the temperature of water before heating. Record on data sheet.

8. Punch a couple of holes around the circumference of the bottom of the large Remove the bottom from the large can. Ignite the wood shavings and quickly place the larger can over the burning wood shavings.



Note: Cut along solid lines



9. Lower the small can into the larger can using the ring clamp.

10. Use your thermometer to measure the temperature of the water after heating. Record on the data sheet.

11. Record the change in the temperature of the water on the data sheet. Specific heat of water = $\frac{1 \text{ calorie}}{1 \text{ gram } 1^{\circ}C}$

12. Multiply the temperature change x the mass of the water x .001 to get the heat gained by water. Record on data sheet. (The .001 is for changing grams x Celsius to Calories.)

13. Find the heat content of wood.

$$\frac{\text{heat output}}{\text{mass of wood}}$$

Record on data sheet.

14. An approximate value for the heat content of wood is 1250 Calories/lb or 2.76 Cal/g. This is the accepted standard.

15. How do your experimental results compare with the accepted value of wood?

Percent difference = $\frac{\text{experimental results}}{\text{accepted value}}$

Lesson 2 Lab Activity Data Sheet

1. Mass of water

2. Mass of wood shavings

3. Temperature of H_2O before heating

4. Temperature of H_2O after heating

5. Temperature change of H_2O

6. Heat gained by H_2O = temperature change x mass of H_2O x 1 Cal/g-c° =

7. Heat content of wood = $\frac{\text{heat output}}{\text{mass of wood}}$ =

8. Percent difference = $\frac{\text{experimental results}}{\text{accepted value}}$ =

9. Why was your value probably lower than the average value for wood?

10. How might you improve the design of this experiment?

DATA TABLE 1: Mixing Different Amounts of Water

Measure the amounts of hot and cold water. Find the temperature of each. Add the cold to the hot and measure the temperature of the mixture.

Trial #	Hot Volume H_2O (ml)	Hot Temp. (°C)	Cold Volume H_2O (ml)	Cold Temp. (°C)	Temp. of Mix (°C)
1	50		50		
2	75		25		
3	90		10		

Note: 1 g of water occupies 1 ml of space. Density of mass = 1.0g/ml. Find out how much the temperature changed in the above trials and complete the next table.

DATA TABLE 2: Calculating the Energy Changes

Trial #	Hot Mass H_2O (g)	Hot Temp. Change (Initial-Mix Temp. Temp.) °C	Hot (Mass x Temp. Change)	Cold Mass H_2O (g)	Cold Temp. Change (Initial-Mix Temp. Temp.) °C	Cold (Mass x Temp. Change)
1	50			50		
2	75			25		
3	90			10		

Compare the Hot with the Cold.

Student Worksheet

Problems on Calories

1. How many calories are released when 250 g of water cools from 50°C to 30°C?

2. How many calories are needed to heat 350 g of water from 30°C to 70°C?

3. If 500 calories (2,092 joules) of energy is released from 50 g of water, how many °C will the temperature change?

4. A tub of water loses 10°C in temperature and supplies 13,500 calories (56,484 joules) of heat to a room. How many grams of water are in the tub?

5. A small candle supplies 50 calories (209.2 joules) of energy each minute. How many minutes will it take to heat 100 g of water from 10°C to 35°C?

Student Handout 1

Woody Problems

1. A one-acre woodlot can produce 17×10^6 BTU's of energy per year. How many Calories are equivalent to the number of BTU's of energy in one acre of wood? (Note: There are .25 Calories in one BTU.)

2. There are 7.5×10^8 acres of woodland in the U.S. Using the findings in problem 1, how many Calories of fuel energy could the trees growing in the United States produce?

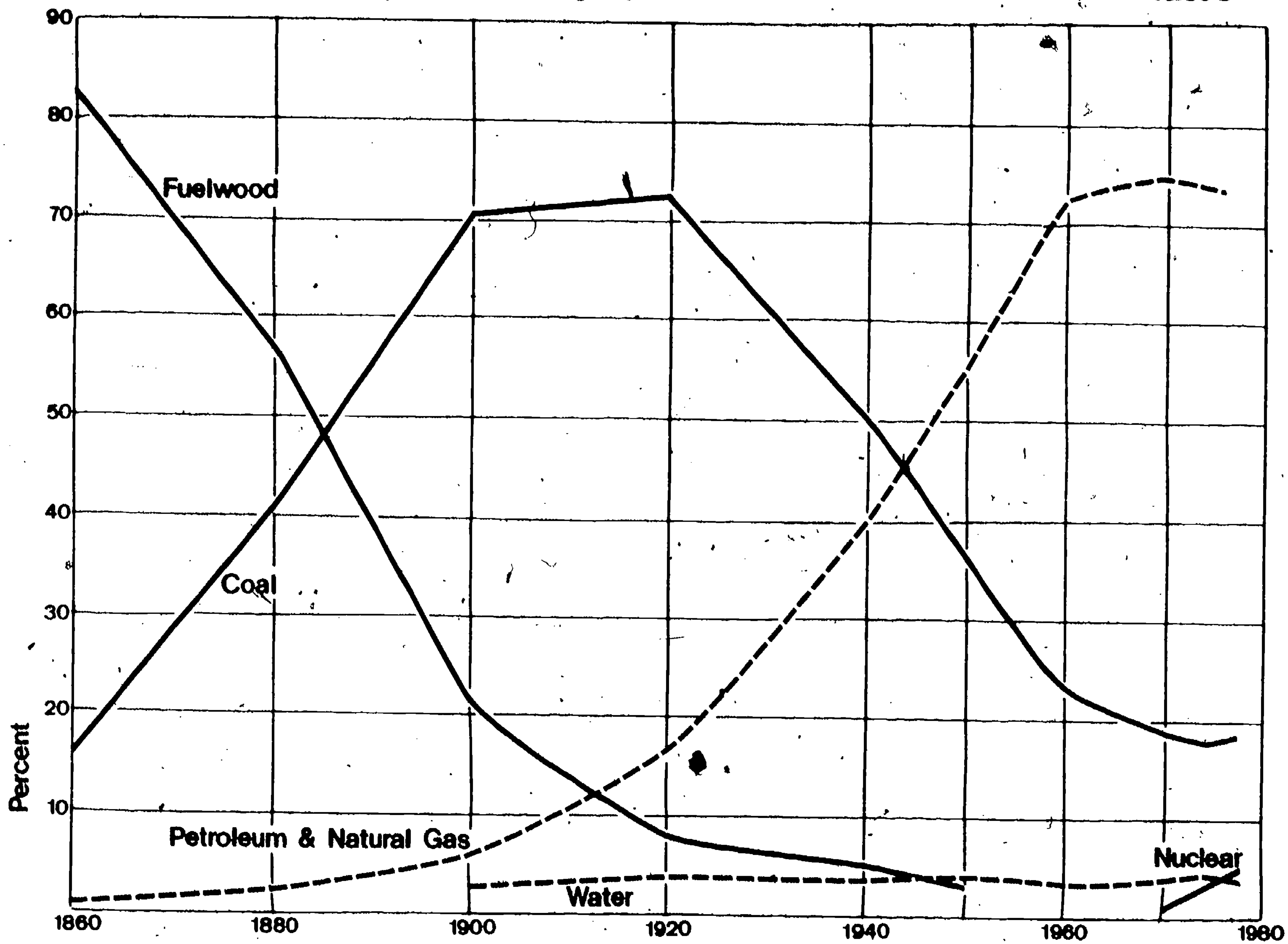
3. A 19th century family used 17.5 cords of wood to heat an average size home for a year. At that time a one-acre woodlot produced about ½ a cord of wood annually. How many acres of wood did they need to produce the 17.5 cords they used? How many BTU's did they use?

4. Total available energy in U.S. forests is 300Q (300×10^{15} BTU's). How many years would this resource last if wood were used for space heating? (In 1978 the residential and commercial sectors used 29.3Q.)

5. In 1978 Americans used 29.3Q to heat their homes and businesses. How many acres of wood would it take to produce that much energy?

6. In a metropolitan area a cord of wood sells for $90/cord. One cord produces 17 x 10^6 BTU's. A fireplace is 10% efficient. What is the cost per million BTU's of room heat from a fireplace? An oil furnace is 70% efficient. A gallon of fuel oil costs about 65¢ and provides .14 x 10^6 BTU's of heat. What is the cost per million BTU's of room heat from an oil furnace? A wood stove is 75% efficient. How does the cost of wood fuel used in such a stove compare with oil?

Changing Fuel Sources in the United States



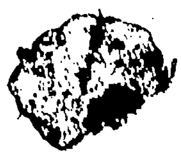
Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

Questions to Accompany Student Handout 1

CHANGING FUEL SOURCES IN THE UNITED STATES

This graph shows the changes in the major energy sources in the United States.



1. In what year did wood make up over 80% of the energy used in the U.S.?

2. In what year was energy supplied equally by wood and coal?

3. In what year did coal reach its peak of importance as an energy source?

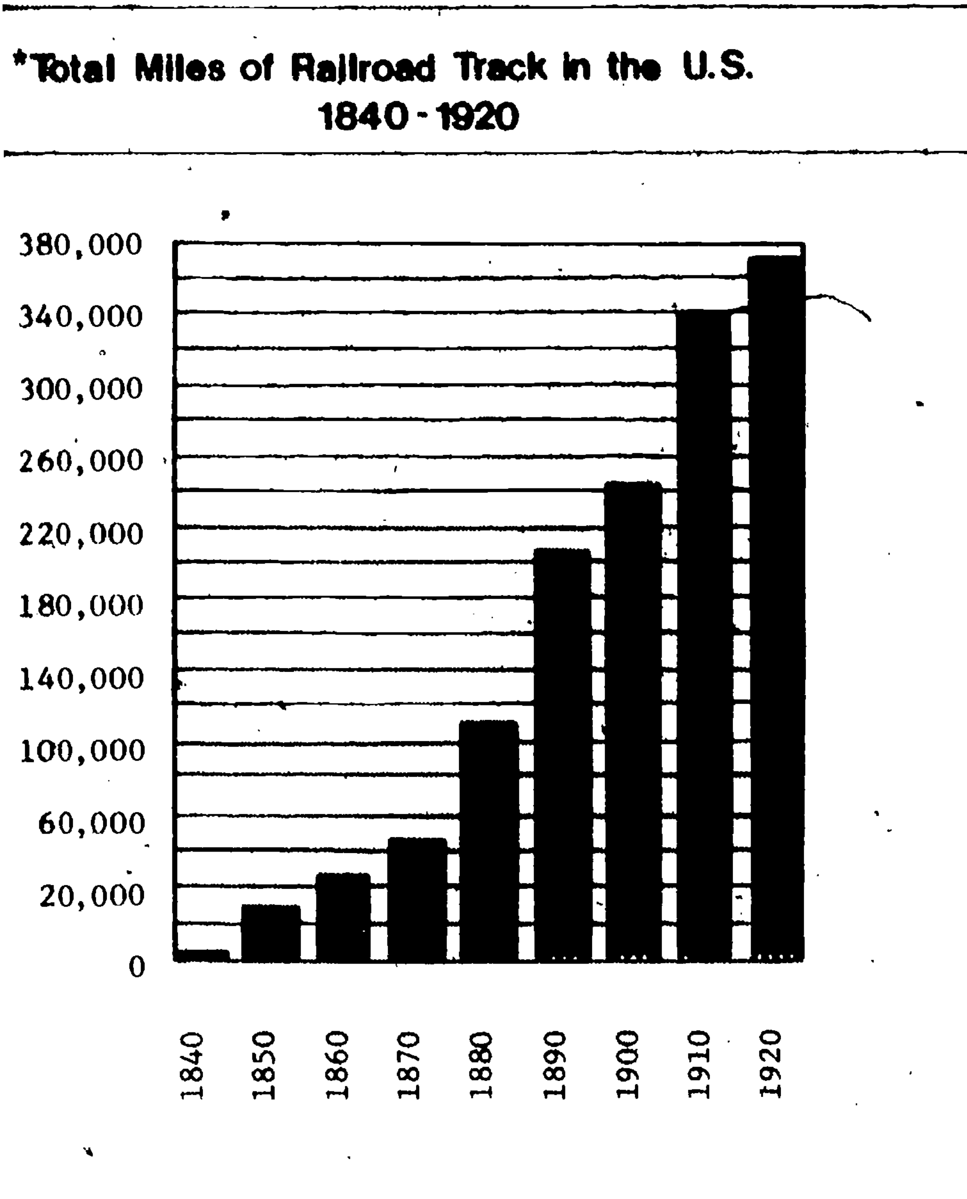
4. Based on this graph, what period of time would you label "The Age of Coal?" Why?

The rest of this unit deals with the question of why coal rose and then fell in importance. Before going on to the other lessons, list as many reasons as you can for this change. When you have finished the unit, look back on this list. Make whatever changes you feel necessary.

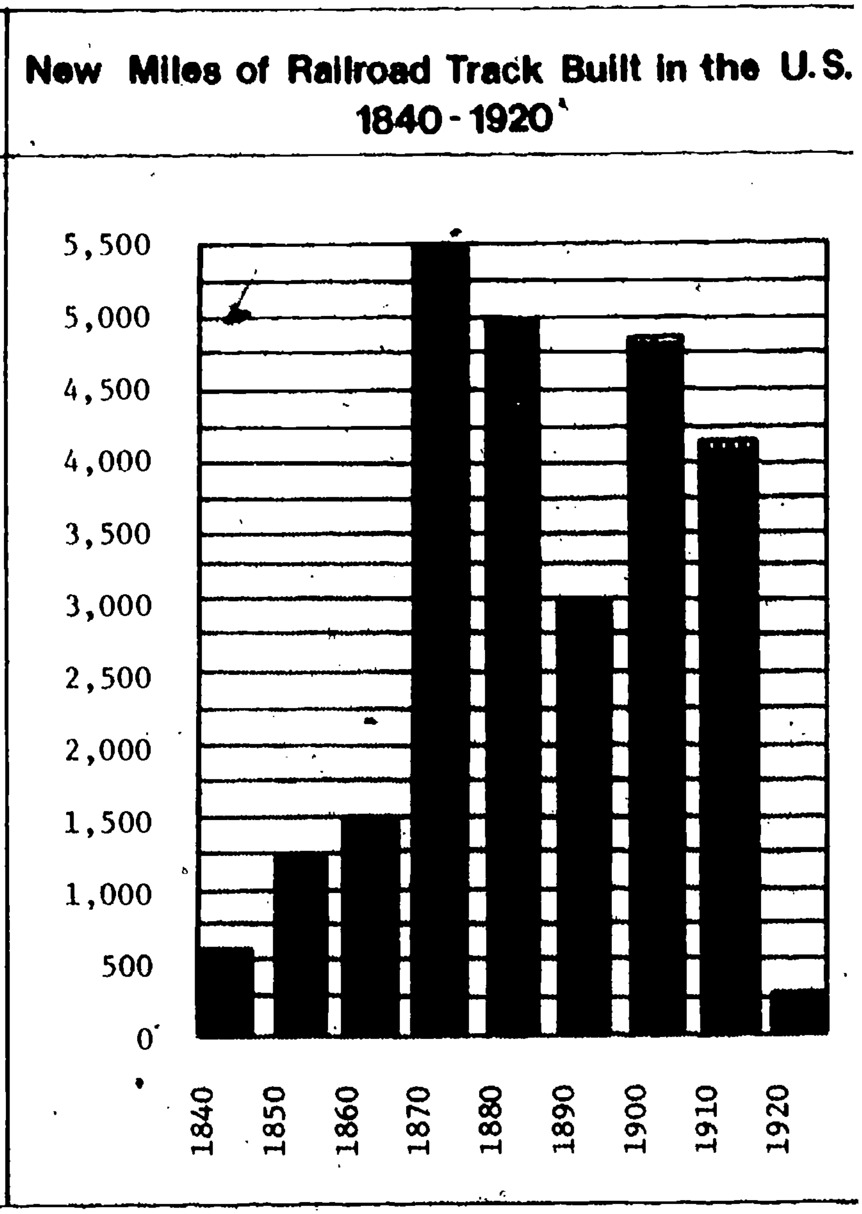
Student Handout 2

Growth of Railroads

Graph A



Graph B



*Note: 1 mile - 1.6 kilometers.

Questions to Accompany Student Handout 2

GROWTH OF RAILROADS

Look at graphs A and B which are called bar graphs. Then answer the following questions.

1. What do the horizontal lines in both graphs tell you?

2. What time period is covered by the graphs?

3. What does the vertical axis show in Graph A?

4. What does the vertical axis show in Graph B?

5. How many miles of track were there in 1860?

   In 1870? In 1920?

6. How many new miles of track were built in 1860?

   In 1870? In 1920?

7. Write a statement showing the trend in railroad growth between 1840 and 1920 in the United States.

8. Write one or two sentences showing the differences between the two graphs.

Student Handout 3

Making a Pictograph

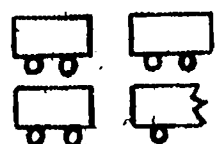
You have looked at two graphs showing railroad growth. Now you are to make a new type of graph. The graph is called a pictograph. Pictures are used to show different amounts of railroad track.

The title of the graph is "New Miles of Railroad Track Built in the U.S." Be sure to use the correct graph from Student Handout 2 to complete your pictograph.

To make things easier, round off the numbers to the nearest hundred. For example, 620 or 649 becomes 600. If the number ends with 50 or more, raise the number to the next hundred. For example, 650 rounds off to 700.

On this graph, each railroad car represents 1000 miles of track. You must estimate what fractional part of a car you will need to draw to show some numbers. Look at the examples below.

2,000 -
1,600 -



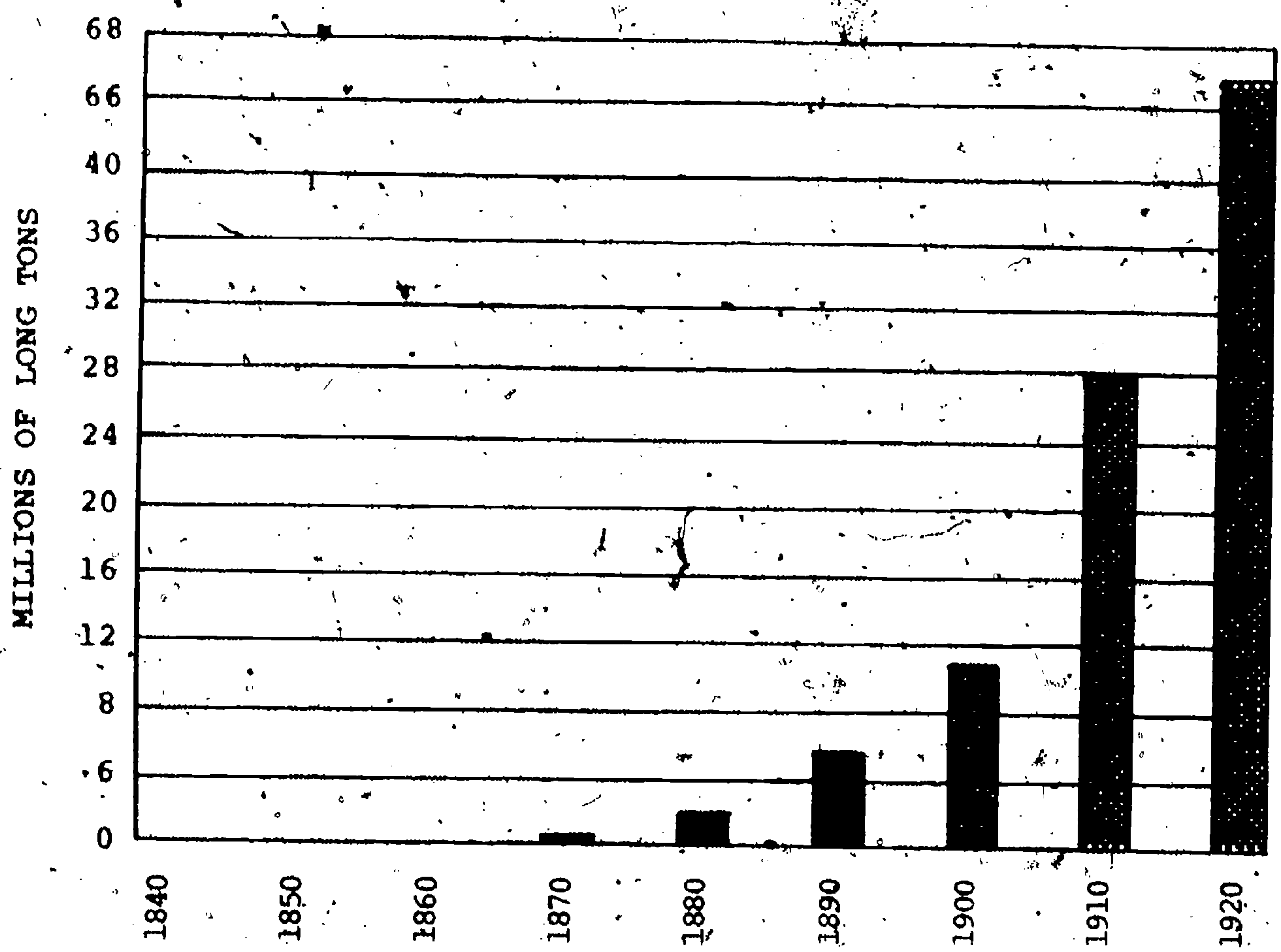
Now fill in this chart: (One is already done for you.)

Year	Miles of New Track	Round off to nearest hundred	Pictograph (Use one column for each car or part of car)						
1840	606	600							
1850	1,261								
1860	1,500								
1870	5,658								
1880	5,006								
1890	3,000								
1900	4,894								
1910	4,122								
1920	314								

Look at the pictograph that you have just completed. What ten year period showed the greatest growth in railroad production?

a. 1850 to 1860 b. 1860 to 1870 c. 1880 to 1890

Production of Steel Ingots & Castings in the U.S.



Look at the graph on this page. Then answer each question on the next page on your own paper.

Questions to Accompany Student Handout 4

PRODUCTION OF STEEL, INGOTS & CASTINGS IN THE UNITED STATES, 1840-1920

1. What kind of graph is this?

2. What does the vertical axis show?

3. What does the horizontal axis show?

4. What period of time is covered on this graph?

5. When was steel first produced in this country?

6. Between what years was there the greatest jump in the production of steel?

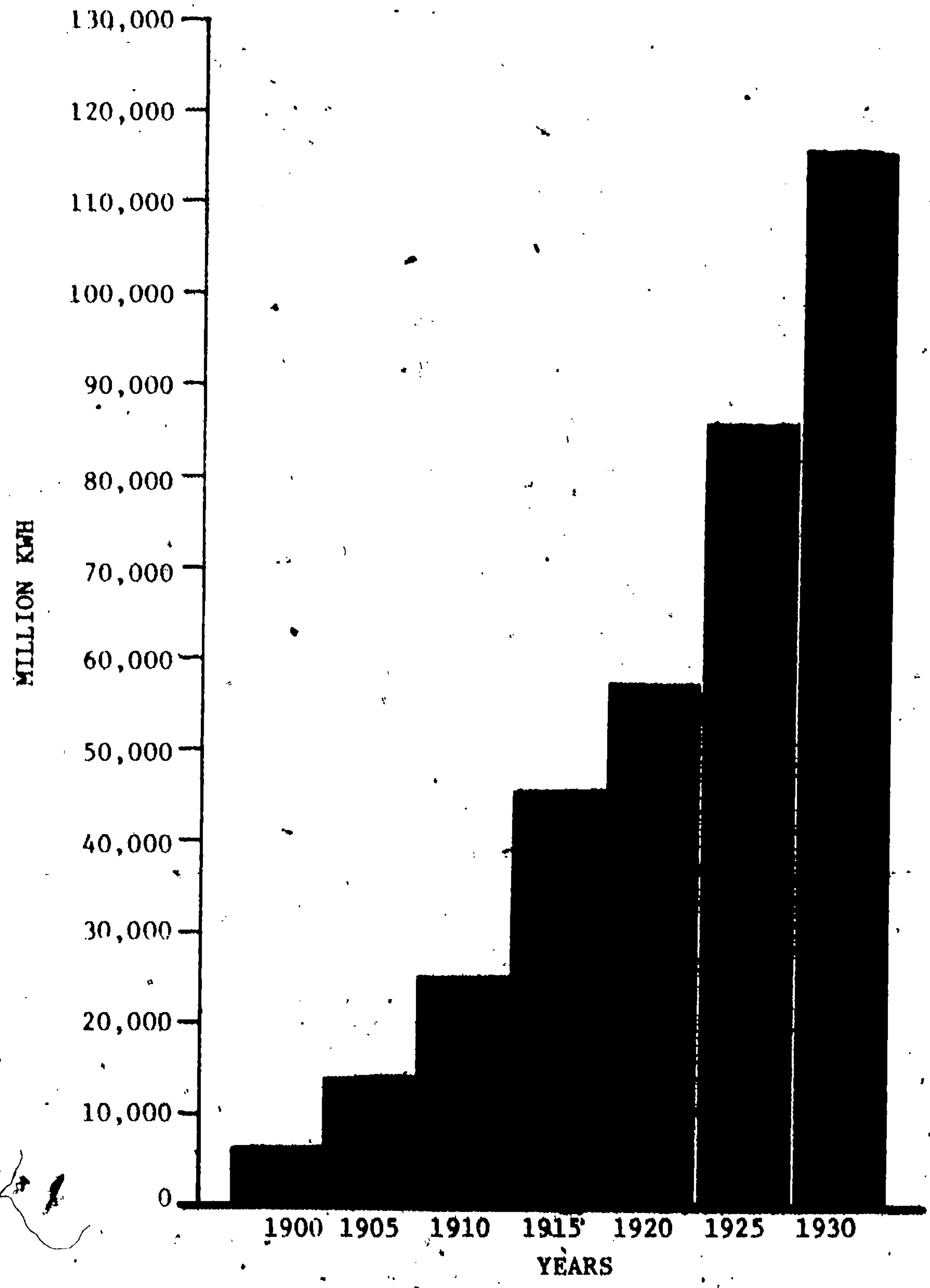
7. What trends do you see in the production of steel in this time period?

8. After examining the chart on steel production, look back at the graph on railroad growth. What similarities and differences do you see?

9. What is the relationship between steel production and railroads?

10. What is the relationship between steel production and coal?

Electricity Consumed in the U.S.



from Edison Electric Institute. *Historical Statistics of the Electric Utility Industry Through 1970.* (New York: Edison Electric Institute.

Questions to Accompany Student Handout 5

ELECTRICITY CONSUMED IN THE U.S.

1. What does the vertical axis show?

2. What does the horizontal axis show?

3. What is the general trend depicted in the bar graph?

4. How many millions of kilowatt hours were consumed in the U.S. in 1905?

5. How many millions of kilowatt hours were consumed 20 years later?

6. List as many reasons as you can for the increasing consumption of electricity during the period included on the graph.

Student Handout 6

Population of the United States

1850	23,261,000
1860	31,513,000
1870	39,905,000
1880	50,262,000
1890	63,956,000
1900	76,094,000
1910	92,407,000
1920	106,461,000

1. What trend do you see in the population?

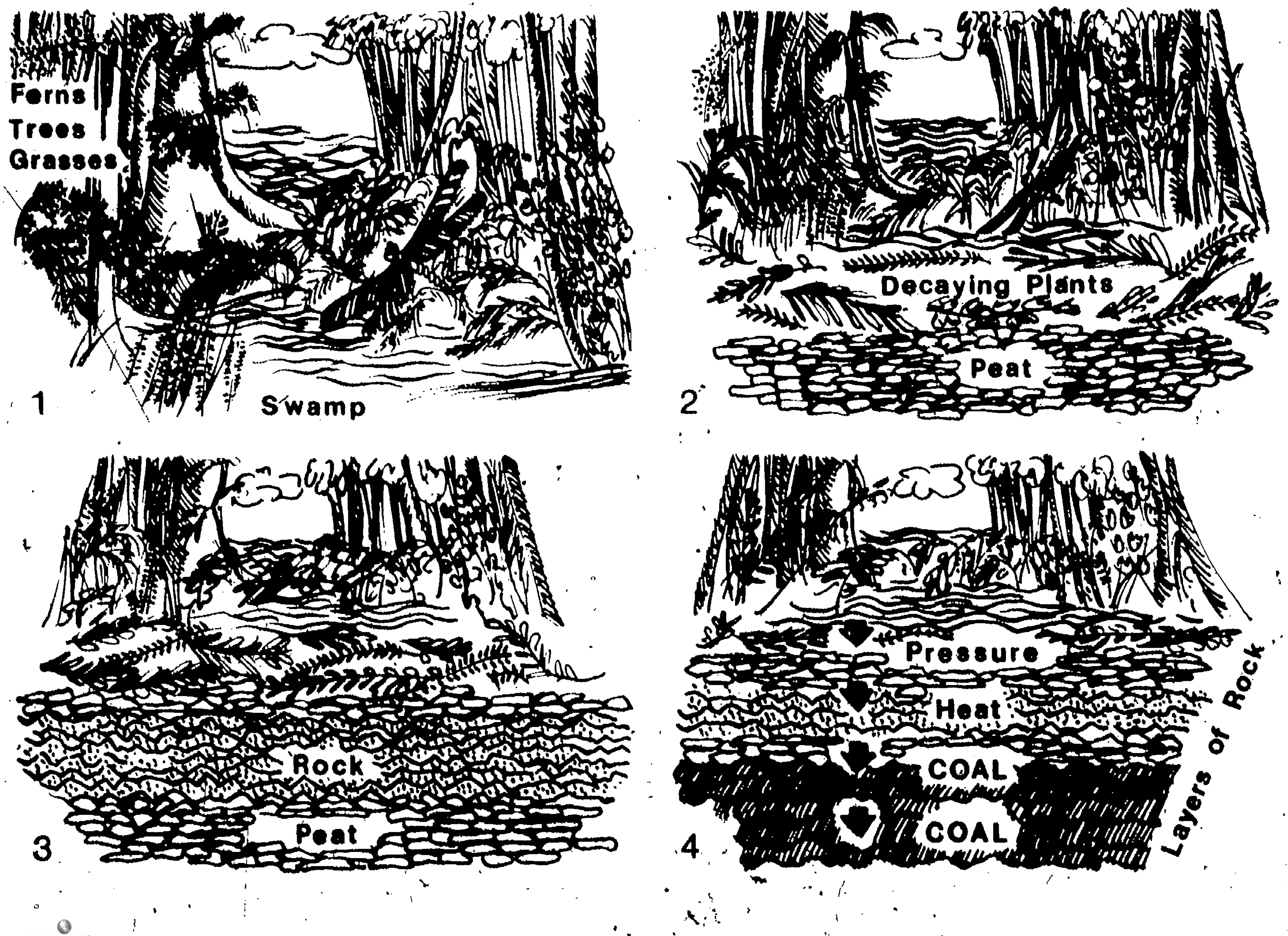
2. What is the relationship between a growing population and the need for coal?

3. Use the data in the table to make a graph. You can make a bar graph or a pictograph. Be sure to label the vertical and horizontal axes. Give your graph a title.

Lesson 5
Student Handout 1

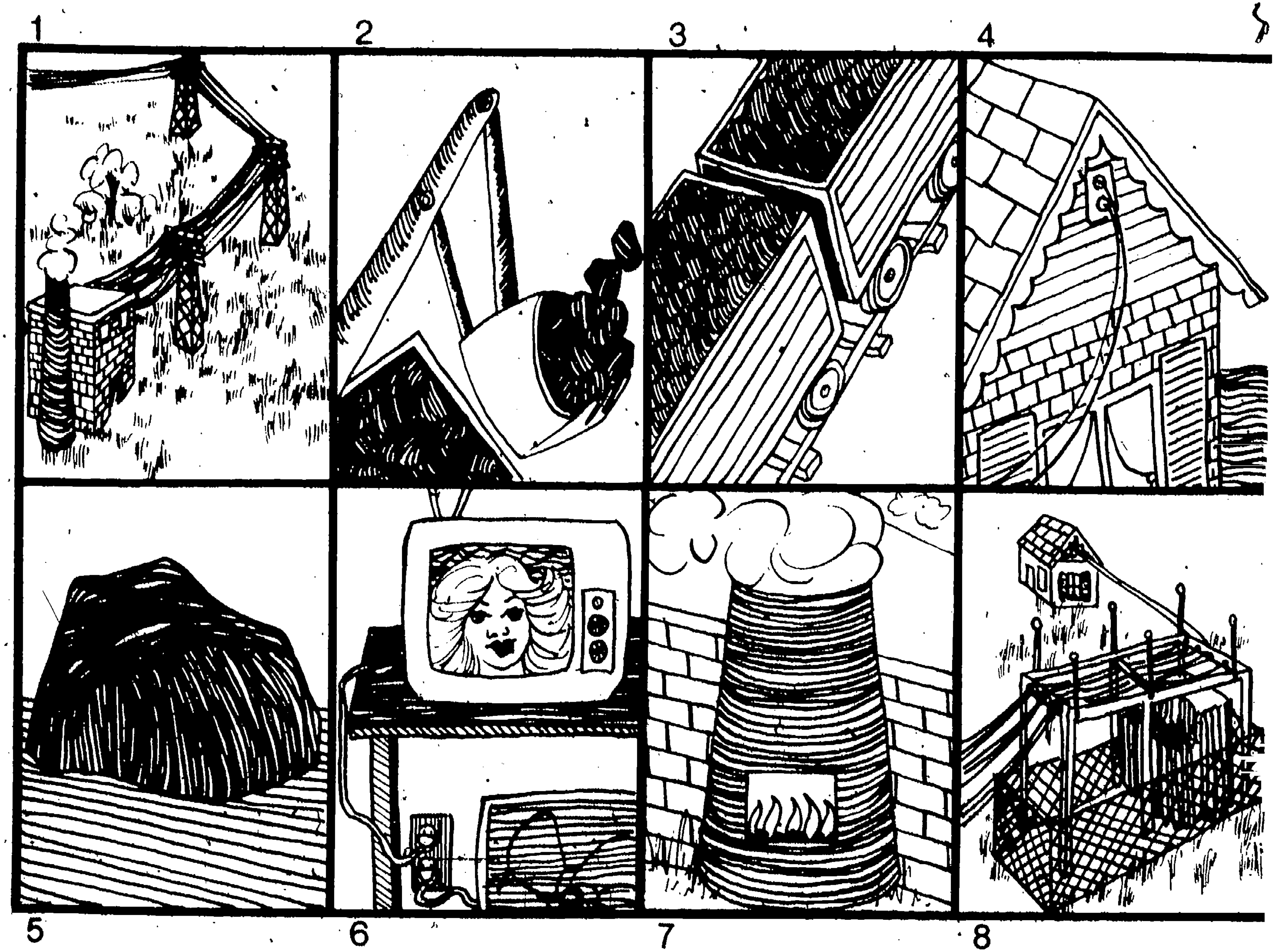
The Coming of Coal

HOW COAL WAS FORMED



Student Handout 2

TRACING COAL



Student Handout 3 — A Working Model of a Steam Turbine

Purpose

This activity will show that steam can turn a turbine (which is what happens at a power plant).

Materials

- medicine dropper
- test tube (attached to support rod)
- Bunsen burner
- stopper (one-holed)
- needle
- thimble
- scissors
- pencil with an eraser
- manila circles
- ruler
- compass

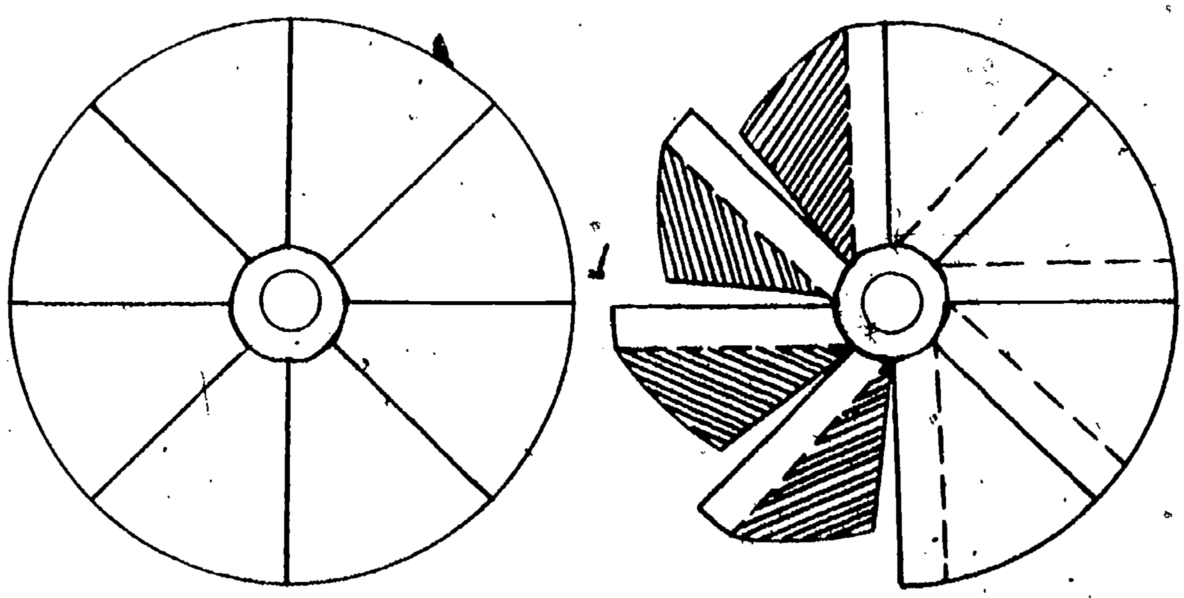
Directions

Make the turbine wheel first. Use the compass to draw a circle 12 centimeters in diameter on the manila folder. Use the same center for the compass, and draw a 2 centimeter diameter circle inside the larger circle. Place the thimble open end down on the center of the circle you have drawn, and draw a third circle around the thimble.

Use the scissors to cut along the inside of this third circle. Use the ruler to draw eight equal parts.

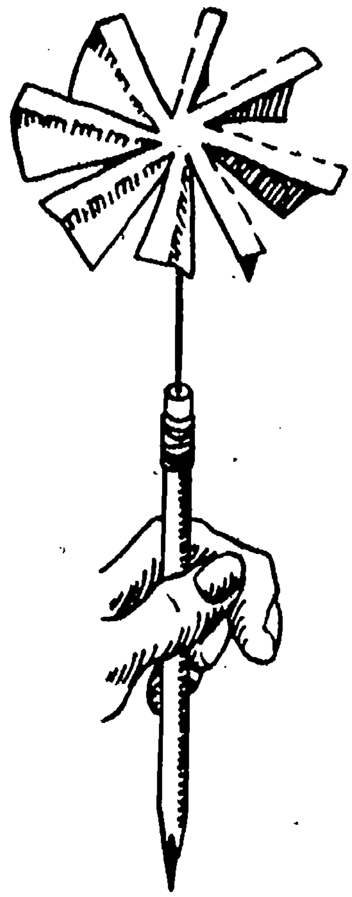
Cut along the lines to the drawn inner circle. Next, bend half of each section back along the dotted lined in the diagram (see Diagram 1). The paper halves should show right angles.

Diagram 1



Insert the needle into the rubber eraser of a pencil. Push the paper turbine wheel over the tip of the thimble and set the inside of the thimble on top of the needle (see Diagram 2).

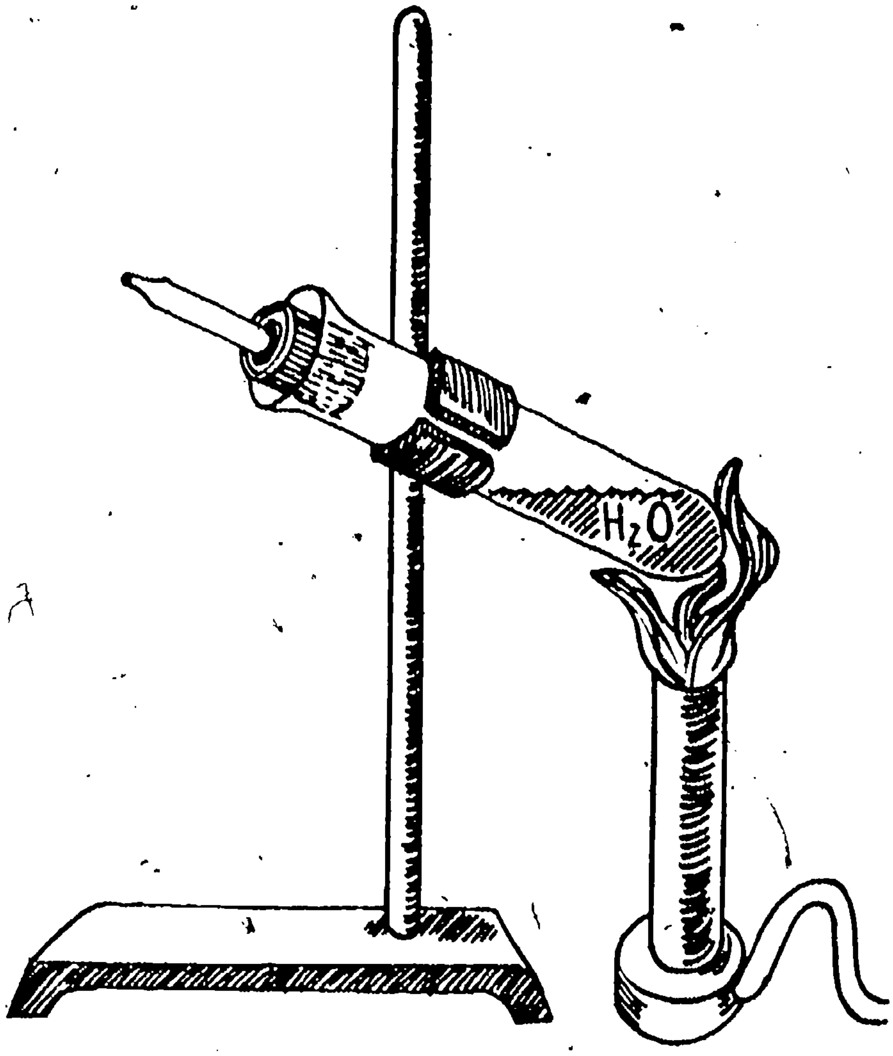
Diagram 2



Operation

Put about 3 cm of water in a test tube and assemble the equipment (see Diagram 3). Remove the top from the medicine dropper and insert the dropper carefully through the one-holed stopper. Insert the stopper into the open end of the test tube, but don't push it in too tightly. Light the Bunsen burner and heat the water in the test tube.

Diagram 3*



Hold the pencil with the thimble top of the turbine attached in such a way that it turns freely, and direct the path of the steam against the paper blades of the turbine.

1. What is happening to the blades?

2. Can you explain why this is happening?

*Caution: Use a plastic medicine dropper if possible and take care that no student is standing directly in front of that potential projectile.

Student Activity 4A — Producing an Electric Current

Purpose — To show that by passing a magnet through a closed coil of wire we can produce electricity.

Materials —
a bar magnet
a cardboard tube
copper wire
a galvanometer (a device that detects the pressure of an electric current)

Directions —
1. Set up apparatus as shown below in Figure 1. Make coil by wrapping wire around cardboard tube.

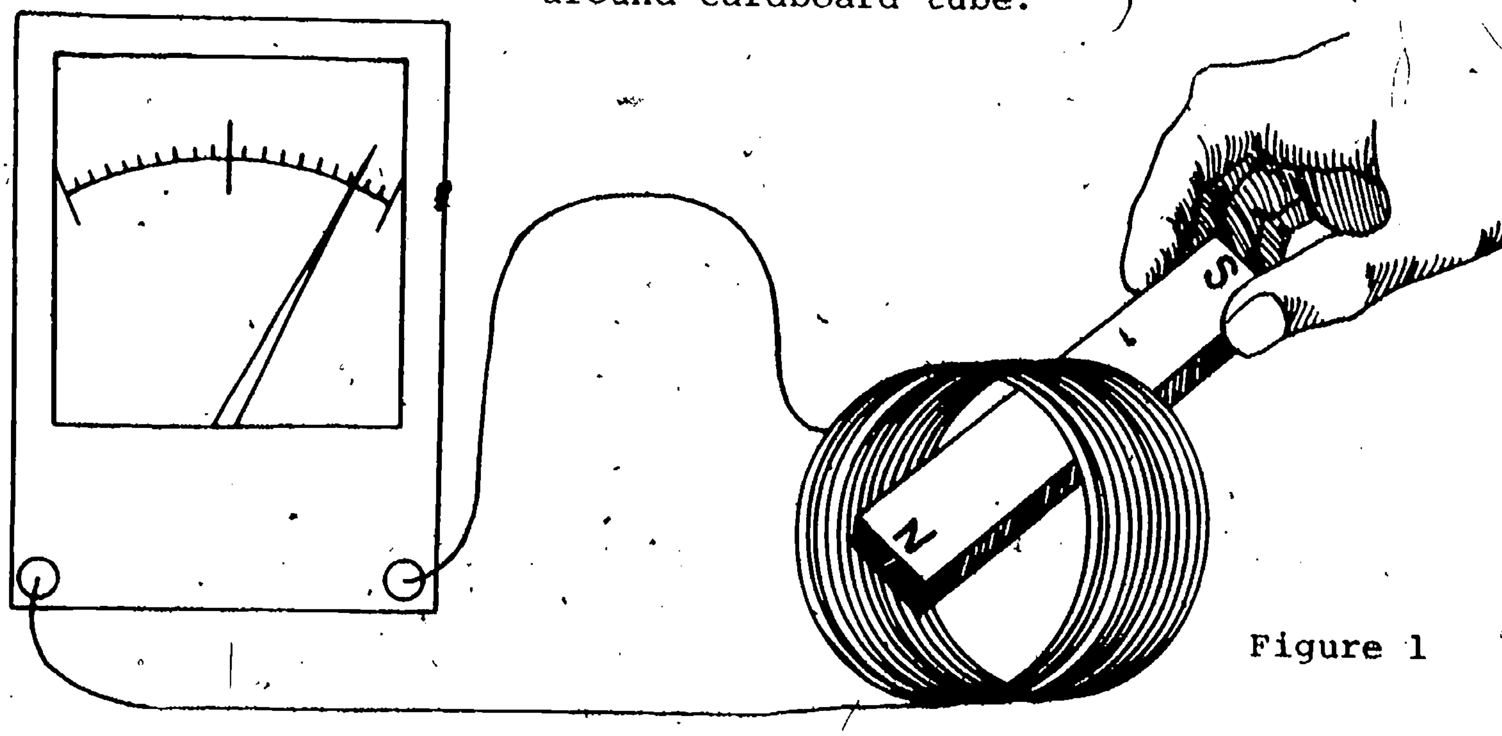


Figure 1

2. With a back and forth motion, move the bar magnet into and out of the coil of wire.

3. Look at the needle on the galvanometer and observe what happens.

How can you produce a stronger electric current? Write your idea in the space below.

Student Activity 4B — Producing an Electric Current

Materials

U magnet
galvonemeter
copper wire
cardboard tube

Directions

1. Set up apparatus as shown in Figure 1.
2. Connect the ends of a flexible wire to the terminals on your galvanometer.
3. Holding the wire vertically, move it briskly between the poles of the U magnet (cutting across the magnetic field).
4. Observe what happens to the needle of the galvanometer.
5. Now make a coil of wire (25-40 turns) and move the coil between the poles as shown in Figure 2.
6. Observe what happens.
7. Is it necessary to have several wires cutting across a magnetic field to produce electricity? Why?

Figure 1

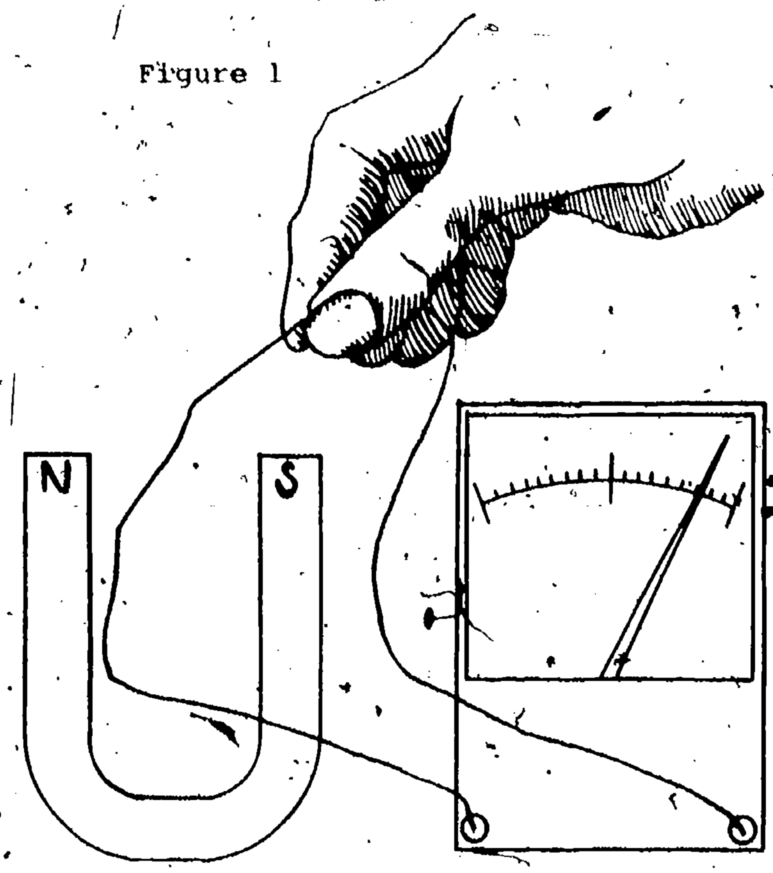
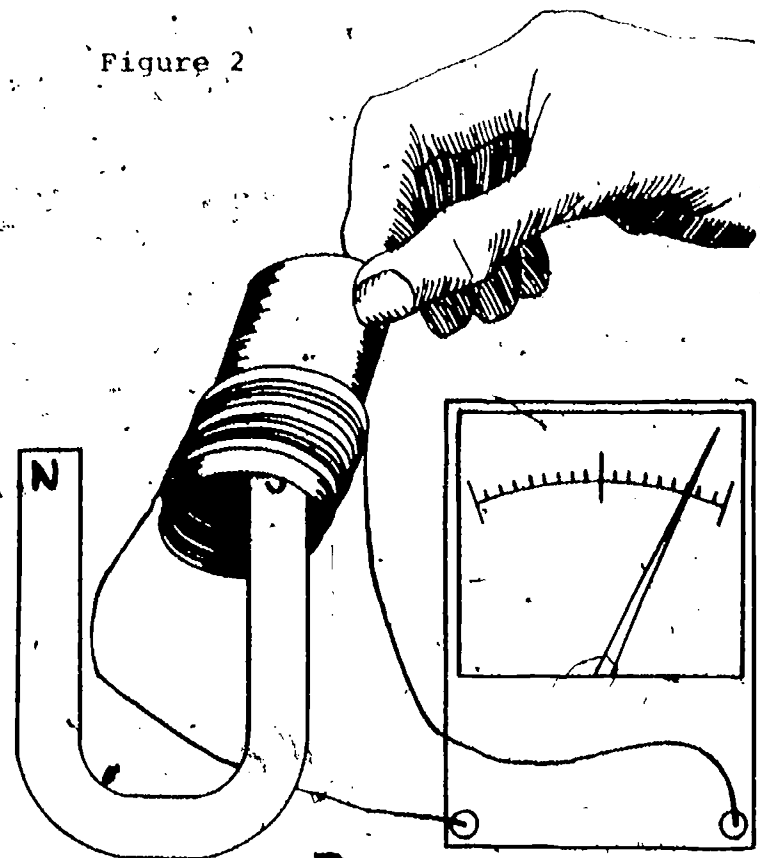


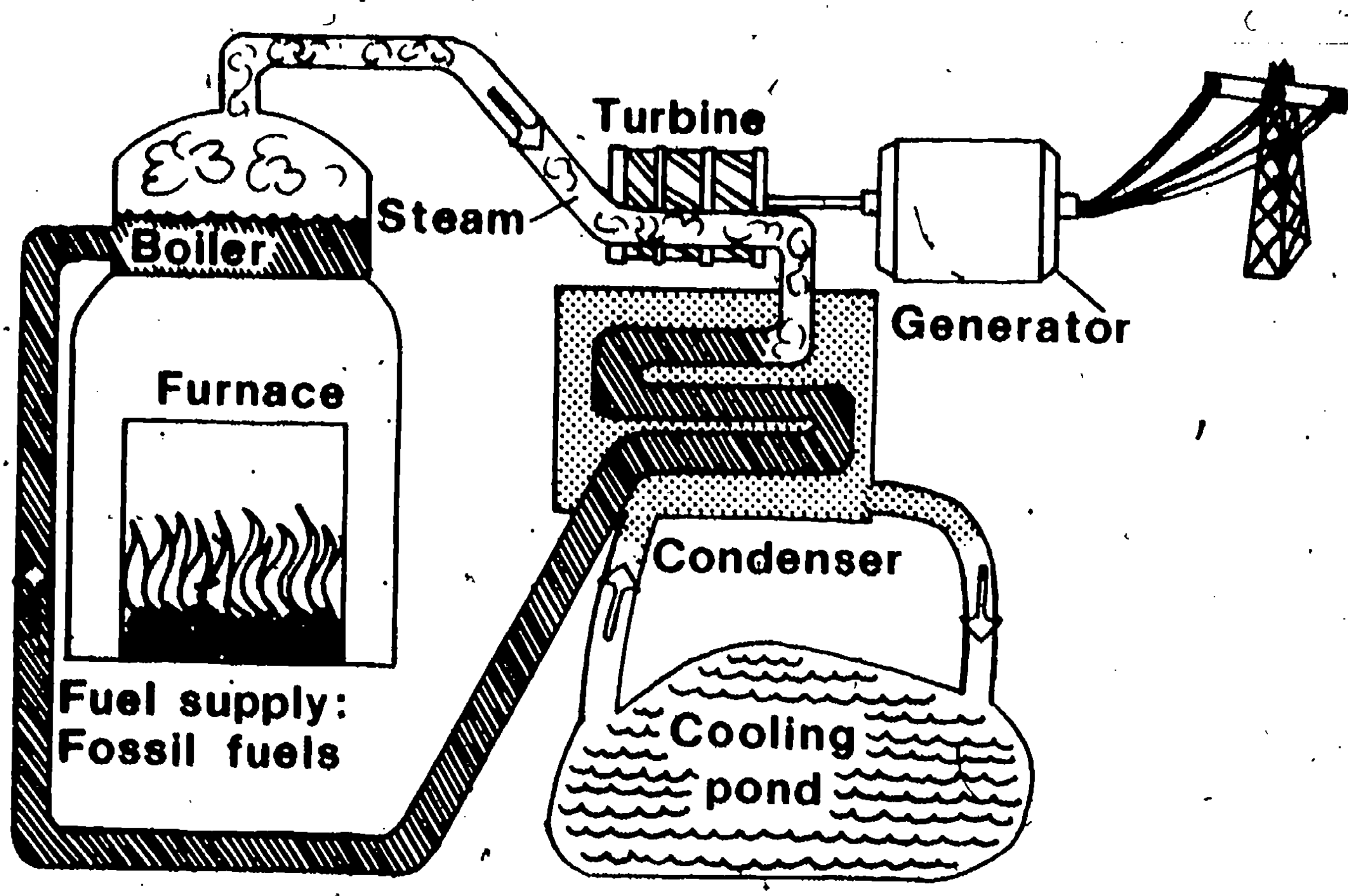
Figure 2



Student Handout 5

Power Generating Plant

Compare each part of the picture to the models you have made.



Based on this picture and your models explain the step by step method of how coal is used to make electricity.

Student Handout 1

Oil-Based Products

antenna cable
credit cards
permanent-press clothes
heart valves
crayons
disposable diapers
parachutes
telephones
enamel
transparent tape
vinyl siding
safety flares
bubble bath
bookends
deodorant
panty hose
bedspreads
plastic tubs
shag rugs
lunch boxes
jerseys
windshield wipers
phonographs
car sound insulation
garment bags
fences
kitchen counter tops
pillows
dune buggy bodies
checkers
soap dishes
syringes
shoes
volley balls
sleeping bags
electrician's tape
mascara
flags
oxygen masks
ink
hair spray
steering wheels
food wraps
rubber duckies
seed tape
card tables
ping pong paddles
purses
weed killers
football pads
puzzles
carbon paper
dishdrainers
puppets
upholstery
hearing aids
earphones
whistles
clothesline
carpet sweepers
chess boards
yardsticks
slip covers
patio screens
mats
refrigerator linings
floor wax
panelling
earrings
false eyelashes
no-wax floors
golf balls
lighter fluid
attache cases
wet suits
laxatives
trash cans
brassieres
acrylic paints
vacuum bottles
bearing grease
rafts
sockets
tiles
air-conditioners
wallets
backpacks
rubbing alcohol
epoxy glue
oil filters

mailboxes
uniforms
pacifers
cassette tapes
luggage
antifreeze
flashlights
motorcycle helmets
antibiotics
shower doors
sugar bowls
decoys
tobacco pouches
pencils
model cars
garden hoses
lawn sprinklers
playing cards
dolls
bubble gum
coasters
straps
tires
rulers
boat covers
unbreakable dishes
toothpaste
tents
finger paints
glycerin
foot pads
lamps
ice cube trays
swimming pool liners
cough syrup
hair dryers
styrofoam coolers
brake fluid
draperies
car battery cases
hockey pucks
fertilizers
knitting yarn
sandwich bags
tableclothes
toothbrushes
notebooks
darts
flea collars
stadium cushions
hang gliders
sandals
lipstick
electric blankets
lamp shades
skateboard wheels
guitar strings
jugs
eyeglasses
vinyl tops
TV cabinets
measuring tape
water softeners
microfilm
tennis balls
measuring cups
dishwashing liquid
extension cords
combs
plastic varnish
badminton birdies
bird feeders
hair curlers
laminates
visors
tennis rackets
canisters
computer tape
ammonia
gaskets
monkey bars
venetian blinds
digital clocks
life jackets
model planes
insect repellent
fishing net
hair coloring
rubber cement

Student Handout 2

The Development of Oil

The cry, "We've struck oil," made farmers angry in 1800. Some people knew how to use the dark, gooey substance for medicine. Others could use it to seal roofs and boats. Some used oil for light. For the most part, however, oil hurt the farmer. It ruined the soil.

In the early 1800's most Americans earned their living on farms. These early farms used little energy. Wood and coal, along with animal and human muscle, provided most of the needed power. Lard or tallow candles and whale oil or petroleum lamps were used for light. Few people travelled further than they could walk. Most of the items used were made in the home.

Over the next hundred years the nation changed tremendously. The total number of people, the way they made a living and where they lived all changed.

Population grew rapidly. There were fewer than ten million people living in the United States in 1820. By 1920 there were over 100 million people. Many of these people lived in cities rather than on farms. The table below will give you an idea of just how fast the cities grew.

CITY	1820	1860	1880	1900
New York	152,000	1,174,800	1,912,000	3,437,000
Philadelphia	63,000	565,500	847,000	1,294,000
Boston	43,400	177,800	363,000	561,000
Baltimore	62,700	212,400	332,000	509,000
Cincinnati	9,600	161,000	255,000	326,000
St. Louis	10,000	160,800	350,000	575,000
Chicago		109,300	503,000	1,698,000

Cities need more energy than rural areas. Streets and factories must be lit. Large buildings must be heated. People and supplies must be transported.

The Industrial Revolution attracted people to the cities, and the cities grew. This "revolution" was a change in the way things were made. In the past, items such as cloth, furniture and rifles had been made at home by hand and by simple machines. Now they were made in factories by workers using power driven machines. With these machines a few workers could produce many more items at a cheaper cost than they could at home. However, the machines required great amounts of energy to work. The manufactured items then had to be transported to the buyers. This also required a great deal of energy. As a result, the factory system of manufacturing is often referred to as an "energy intensive" system.

With the growth of population, the growth of cities, and the growth of the factory system, the demand for energy increased enormously. This increased demand for energy drove the price of energy up. As the price rose, investors saw a way of profiting from the discovery of cheap, abundant, and efficient energy sources.

Scientists and engineers around the world conducted experiments to find this new source of energy. In Canada, Abraham Gesner used natural oil to produce "keroselain." This was later called "kerosene." In Pittsburgh, Samuel M. Kier used petroleum produced by salt well. He developed a way to refine the oil. By 1858, Kier's firm was selling great quantities of "Carbon Oil" at $2.00 a gallon. But the demand for oil was still greater than the supply and the price kept rising.

In another part of Pennsylvania, a group of businessmen led by James M. Townsend formed a company to drill for oil. They reasoned that this would be a profitable way to invest their money. They hired Edwin L. Drake, a retired railroad conductor, to undertake drilling operations. The site chosen was on the banks of Oil Creek at Titusville, Pennsylvania.

Drilling went slowly. People began calling the project "Drake's folly." Laborers quit. The townspeople ignored the project. But the developers still thought they would reach oil and make a profit. They continued to risk their money. The investors hired W.A. Smith as the chief driller.

On Saturday, August 27, 1859, Smith stopped the drill at 69½ feet. Late the following day, Smith walked past the well. He noticed something strange. A dark, green fluid filled the hole. He lowered a cup and pulled it up. The cup was filled with oil. "We've struck oil!" "We've struck oil!" became the cry of a new gold rush.

Questions to Accompany Student Handout 2

THE DEVELOPMENT OF OIL

1. Was oil valuable to the people in the United States around 1800?

2. Was oil used as an energy source before 1800?

3. Why did farmers dislike finding oil?

4. List three reasons why the demand for energy increased between 1820 and 1920.

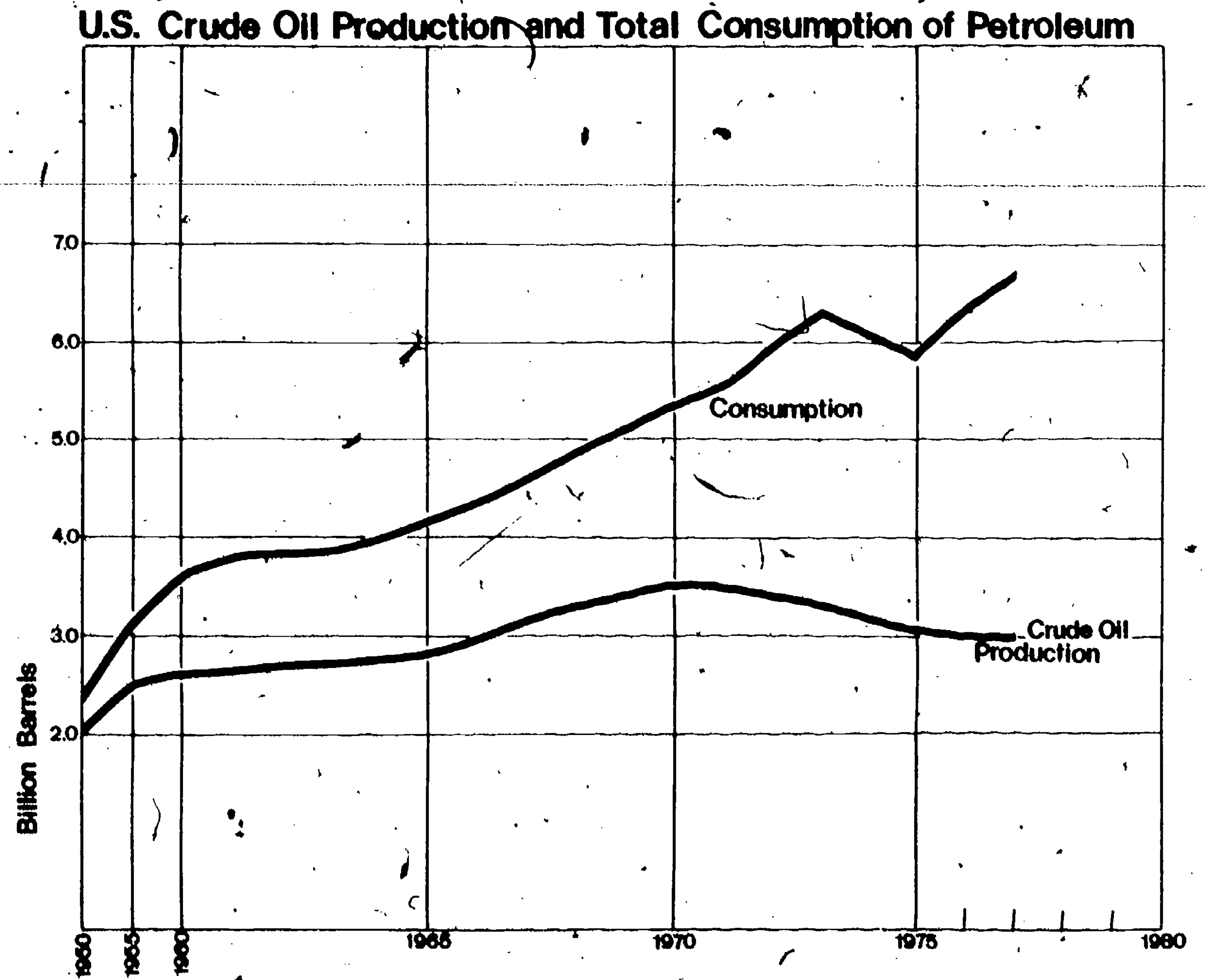
5. Why did investors put their money in oil development after 1850?

6. What does the term "energy intensive" mean?

7. What did people mean when they called the drilling project "Drake's folly?"

8. In the last paragraph, why is striking oil compared to a gold rush?

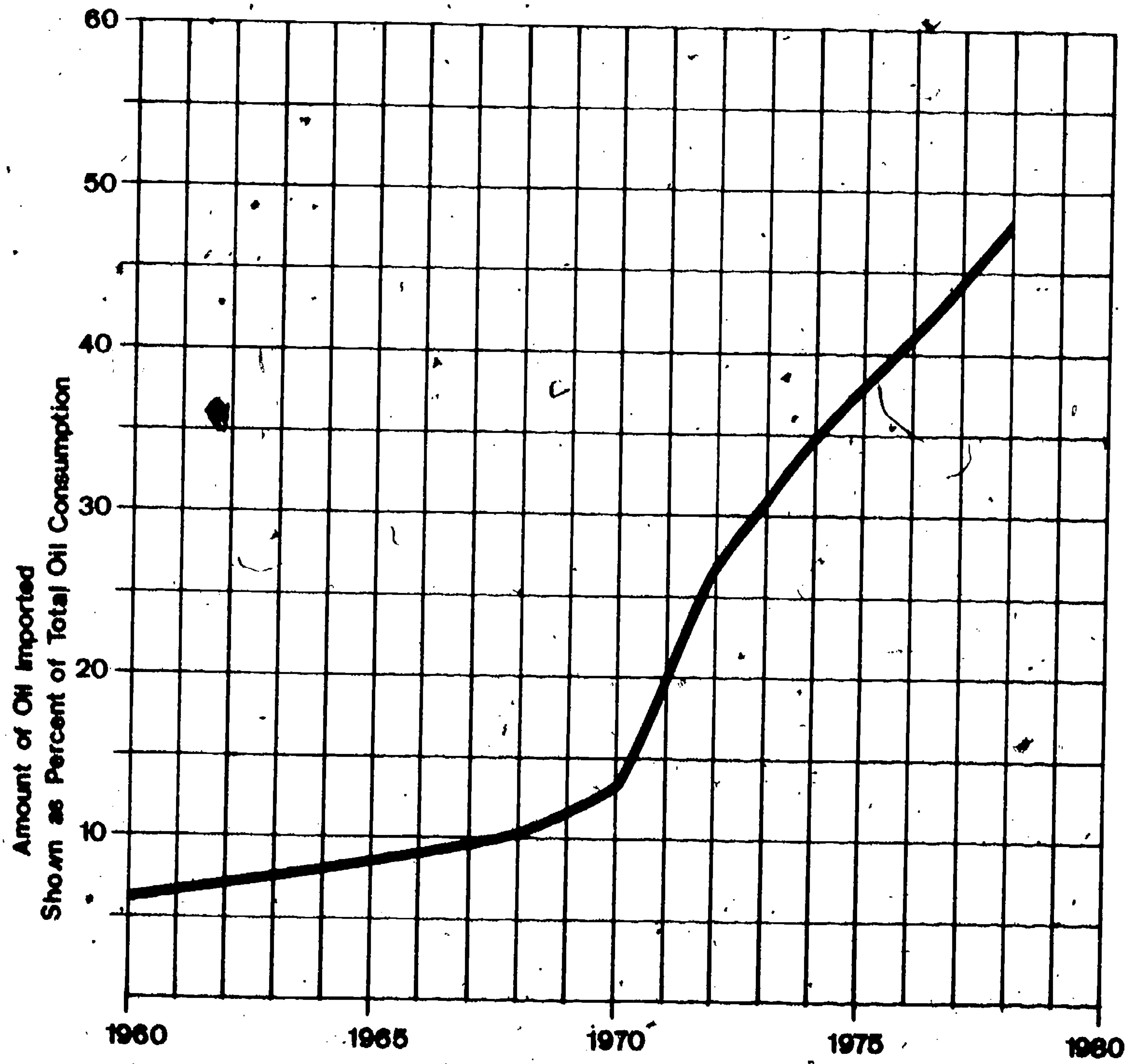
Student Handout 3
Graph 1



Data from: Energy in Focus: Basic Data. (Washington, DC: Federal Energy Administration) 1977.

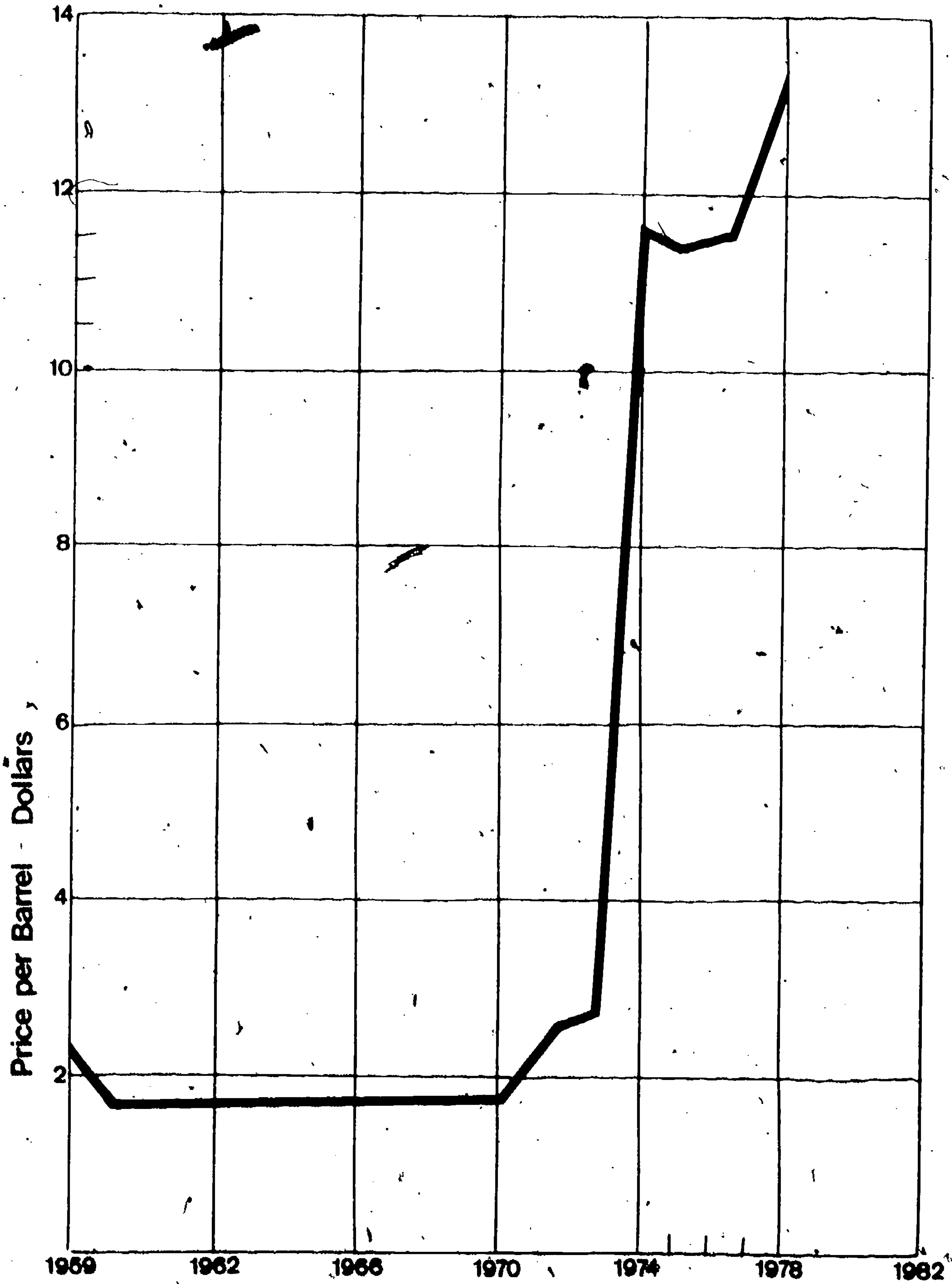
Monthly Energy Review. (Washington, DC: Department of Energy) 1978.

U.S Oil Imports



Student Handout 5
Graph 3

Crude Oil Prices in Arabian and Persian Gulfs



Questions to Accompany Student Handouts 3-5

1. What is the title of Graph #1?

2. What does the vertical axis show?

3. What does the horizontal axis show?

4. What is the time span of the graph?

5. What is the trend in total consumption?

6. What is the trend in crude oil production?

7. Between which years were total consumption and crude oil production growing at <u>about</u> the same rate?

8. In which years were total consumption more than twice as much as crude oil production?

<u>Bonus Question</u>

Where does oil come from that is not produced in the United States?

9. What does Graph #2 show?

10. What percent of the oil used in 1966 in the United States was imported?

11. What percent of the oil used in the United States in 1970 was imported?

12. What does this graph show about the relationship between U.S. production of crude oil and total consumption of petroleum?

13. Look at Graph #3. What ~~can~~ you learn from the graph?

14. Using the three graphs in this section, what reasons can you give for the rise in the price of Middle Eastern oil?

15. What effects do you think the rising price of oil will have on the U.S. culture and economy?

Lab Activity Sheet — HEAT CONTENT OF OIL

Purpose: To determine the heat content of oil.

Materials

- fiberglass insulation
- glass stirring rod
- Bunsen burner
- ring stand with clamp
- thermometer (40°-150°C)
- small juice can with metal bottom
- large metal juice can
- can opener
- 3-in-1 oil
- platform balance
- screen wire
- scissors
- matches

Procedure

1. Weigh 100 ml of water and put in small juice can. Record on data sheet.
2. Read the temperature of the water. Record it on data sheet.
3. Make a small stand out of the piece of wire screen. See diagram in Lesson 2.
4. Cut a piece of fiberglass insulation about 2.5-3 cm in width and length.
5. Place the small wire screen and fiberglass insulation on the platform balance.
6. Slowly drip 20-22 drops of 3-in-1 oil into the fiberglass. Record the mass of the screen stand, fiberglass and 3-in-1 oil on data sheet. (Weight should be about .3 g or .003 kg.)
7. Use a beer can opener to put holes in the sides of the larger can as shown in diagram in Lesson 2.
8. Remove the top and bottom from the larger can.
9. Using your scissors, punch a small hole in the side near the rop of the small juice can for the stirring rod. Insert stirring rod.
10. Set up equipment as shown in diagram in Lesson 2.
11. Now remove the wire screen, fiberglass and oil from the balance.

12. Leaving the fiberglass on the wire screen, ignite the oil.

13. Raise the large can and cautiously push the burning oiled fiberglass under the juice can containing the water.

14. Lower the large can over the burning oiled fiberglass.

15. After the oil has burned off the fiberglass, record the temperature of the water on the data sheet.

16. Cautiously raise the larger can and remove the wire screen containing the unburned fiberglass to see if you burned all the oil that you started out with.

17. Determine the heat content of oil. See data sheet.

Lab Activity Data Sheet

1. Mass of water ______ml = ______g or ______kg.

2. Temperature of water before heating ______°C.

3. Mass of screen stand, fiberglass and oil before heating ______g.

4. Mass of screen stand, fiberglass and oil after heating ______g.

5. Mass of oil ______g or ______kg.

6. Temperature of water after heating ______°C.

7. Change in water temperature ______°C.

*8. Heat gained by water = temperature change x mass of water x .001 = ______Calories or ______joules.

9. Heat content of oil =

$$\frac{\text{Heat output (heat gained by } H_2O)}{\text{Mass of oil}}$$

= ______________________ = ______________________

**10. Accepted value for heat content of oil is ______Cal/kg or ______megajoules/kg.

11. % difference = $\frac{\text{experimental result}}{\text{accepted value}}$ = ______

*To change calories to kilocalories (Calories) multiply by .001.

**Data taken from Energy and the Environment, by John M. Fowler, McGraw-Hill Book Company, p. 427, 1975.

ENERGY TRANSITIONS IN UNITED STATES HISTORY

Pre-Post Test

WOOD HYDROELECTRIC COAL OIL GEOTHERMAL NATURAL GAS

1. Which of the above was a primary source of energy during the following periods of U.S. History?

   a. The Colonial Period? ____________

   b. The period from 1820 to 1900? ____________

   c. The period from 1900 to the present? ____________

2. Which of the following is not a unit of energy measurement?

   a. BTU

   b. joule

   c. watt

   d. calorie

3. Name three commonly used items that require oil to manufacture. (See list on pp 101-102.)

4. Who was Edwin Drake?

   a. He invented the gasoline engine.

   b. He drilled the first oil well.

   c. He founded U.S. Steel.

   d. He was the captain of the first steamship.

5. List two reasons why the demand for energy sharply increased from the period 1820 to 1920.

6. The amount held by an average freight car is:

   a. equivalent to a gallon of gas.

   b. a stack measuring 4 x 4 x 8 ft.

   c. the amount that can be carried on the back of a strong donkey.

   d. the amount burned in the average fireplace in a week of continuous use.

7. What's wrong with this idea?

"In order to conserve its precious supplies of fossil fuels, the U.S. should switch from coal and oil to electricity."

8. Look at Student Handout, "U.S. Oil Imports." The statement that can be drawn from this graph is that:

a. The U.S. has stopped drilling for oil.

b. Americans are using less electricity.

c. Oil imports steadily increased from the period between 1960 and 1977.

d. Americans paid more for oil in 1977 than in 1960.

9. What does "OPEC" stand for?

a. Organization of Petroleum Exporting Countries.

b. Oil Producing Energy Cartel.

c. Operational Plan for Energy Conservation.

d. Organization for the Promotion of Environmental Controls.

10. A "turbine"

a. converts mechanical energy to chemical energy.

b. converts heat energy to mechanical energy.

c. converts mechanical energy to electrical energy.

d. converts chemical energy to mechanical energy.

11. Look at Student Handout.

a. This picture shows:

-- the process of cooling hot water created when electricity is generated.

-- the generation of electricity from fossil fuels.

-- how a boiler works.

-- the path that electricity takes through a power plant.

b. Using the following terms label the parts of the system: fuel supply, cooling pond, furnace, boiler, turbine, condenser, generator.

c. This system would most likely be found:

-- in a factory.

-- in a power plant.

-- in a house.

-- aboard a ship.

12. Look at Student Handout, "Producing an Electric Current."

a. This picture demonstrates:

-- how an electric current is generated.

-- how a magnet works.

-- how a galvanometer works.

-- how a meter can be used as a compass.

13. Which of the following statements best explains the relationship between the growth of railroads and the increase in the use of coal during the same period of U.S. history?

a. These developments are entirely coincidental.

b. Coal was used to fuel locomotives and to manufacture rails.

c. Railroads were used to transport coal.

d. Railroad lines were owned by the coal companies.

14. The term "energy intensive" is used to designate:

a. process and manufactured goods which require large amounts of energy.

b. a process that requires an energy source having a high "energy per pound" ratio.

c. a power plant that produces electricity for industrial purposes.

d. energy sources which cost more than the goods and services produced by using them.

15. Which of the following statements best explains why coal replaced wood as a primary source of energy for the U.S.?

   a. Coal was less expensive than wood.

   b. The U.S. was running out of wood.

   c. Coal mining provided greater employment opportunities than wood cutting.

   d. Coal was easier to transport and contained more energy per pound than wood.

16. A "generator":

   a. converts mechanical energy to electrical energy.

   b. converts heat energy to mechanical energy.

   c. converts electrical energy to chemical energy.

   d. converts chemical energy to heat energy.

17. The formation of coal requires:

   a. hundreds of years.

   b. thousands of years.

   c. millions of years.

   d. This depends upon the level of technology.

*U.S. GOVERNMENT PRINTING OFFICE : 1979 0-281-742/3006